NATURE

No. 4351 SATURDAY, MARCH 21, 1953 Vol. 171

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T.G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

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COUNCIL FOR THE PROMOTION OF FIELD STUDIES

THE annual report of the Council for the Promotion of Field Studies for 1951–52 maintains the high standard, in presentation and in interest, which we have already, within ten years, come to expect of the Council's reports. With the director's report, and those of the wardens and the accounts, are printed four articles illustrative of the work being done through the field-centres and which will interest a wide range of scientific and professional workers no less than amateurs. They cover excavations in East Suffolk, the aims and methods of geographical field-study developed at Juniper Hall under Prof. S. W. Wooldridge's guidance to train students in the art of looking at country, bird navigational studies on Skokholm Island and the vegetation of Malham Moor.

These articles testify both to the value of the educational work being carried out at the centres and to the potentialities of the centres for the advancement of scientific work. As such they have a fit place alongside the annual report, though the main importance of the document as a whole must lie in the frank account of the activities of the Council and the needs and difficulties of the centres given by the director and his wardens. It is abundantly clear from these plain records how much is due to the enthusiasm and untiring efforts of the director and wardens, the president (Sir Arthur Tansley), the successive chairmen of the Executive Committee (Prof. W. H. Pearsall and Prof. S. W. Wooldridge) and other officers, that the Council has brought its affairs through a critical year to a hopeful issue and kept open its opportunities, alike for science and the amateur scientist.

There may not be in Britain the myriad of voluntary endowments for scientific and other social purposes that characterizes the United States and to which Dr. R. B. Fosdick has directed attention in his recent book on the Rockefeller Foundation. Nevertheless, to a modest degree, the Council for the Promotion of Field Studies undoubtedly provides already in its field-study centres not merely educational opportunities but also potential growing points for scientific work, and it does so partly through voluntary effort. To an increasing extent the maintenance, still more the expansion, of its work depends on further financial support from voluntary sources, and the clear but eloquent exposition of the Council's claims in this report should be sure of sympathetic reception, particularly by scientific workers in Great Britain.

Prof. Wooldridge points out in his foreword to the report that, in accordance with the Ministry's declared intention throughout that the field-centres should become self-supporting, the Ministry of Education's grant is to be reduced in future by at least £3,000 annually from the £8,000 received during 1951–52. This necessitated drastic economies during 1952, including the closing of the central office and severe cuts at the field-centres, three of which are without a full-time assistant warden. In spite, how-

* Council for the Promotion of Field Studies, 1951–52. Pp. 52. (The Director, F. H. C. Butler, Ravensmead, Keston, Kent.)

ever, of considerable strain and anxiety, a full season was worked at the field-centres with bookings exceeding those for 1951: 900 at Dale Fort and Skokholm; nearly 800 at Flatford Mill; 923 at Juniper Hall; and 990 at Malham (slightly less than in 1951). With the new charge of five and a half guineas weekly, continued support from the universities, an increasing number of subscribers and, more recently, some generous grants from industrial organizations, the Council managed to achieve a small balance of income over expenditure.

Besides the reassurance thus given by the experience of the 1952 season, the Council has been registered as a 'charity', which offers the benefit of remission of income tax on covenanted donations additional to the minimum membership subscription. The first large grant under this arrangement was one given by Imperial Chemical Industries, Ltd., which will increase the Council's income from voluntary sources by £750 annually. Besides an anonymous donation of £500 and contributions of £250 (for Malham) from the Albert Reckitt Charity and £250 from Messrs. Fisons of Ipswich, the financial position has been strengthened by closer co-operation with local-authority associations. To facilitate this, the modification of the Council's articles of association was approved at an extraordinary general meeting on December 11, 1952, and in consequence it is anticipated that some help in the way of capital grants may be forthcoming from interested authorities to permit the improvement of the amenities and scientific equipment of the field-centres, particularly Juniper Hall and Dale Fort. The report acknowledges a generous response by some Welsh counties to a recent appeal for capital grants made from Dale Fort itself.

Apart from this question of capital grants, the director's report emphasizes that the maintenance costs of the field-centres are unlikely to be met solely by securing increased numbers of students, even at the higher weekly charges. Additional income from voluntary sources is urgently required, and the two main purposes for which the director suggests such funds are required are most likely to be served effectively if the Council retains the character of a voluntary body. First and foremost, it is necessary to increase the present meagre allocation of scientific staff at the field-centres, both to relieve pressure on the present minimum staff of two throughout the busy part of the season, and to free the staff to undertake those special researches and organize those long-term investigations for which their special qualifications and the unique position of the field-centres together fit them, and which are fundamental to the intellectual life of the centres. Secondly, the Council requires freedom to experiment by introducing courses which should undoubtedly be held but may not necessarily, when first introduced, attract those students who give the best results in term of economics.

It is unnecessary to recapitulate here what was said in these columns two years ago (cf. *Nature*, 167, 1041; 1951) as to the value to Britain's economy to-day of the ecological studies and the field-work which the Council is so well equipped to foster. The present report shows how ably the Council has maintained that work and its potentialities in spite of acute financial difficulties. That record, with Mr. F. H. C. Butler's convincing exposition of the reasons why it is important that the Council should remain a voluntary body and a movement, and not become an institution entirely dependent on State support, warrants the hope that there will be a generous response to this fresh appeal for support from voluntary sources.

One particular appeal is made in this report which deserves a generous response from the smaller industrial firms, as well as from local societies and institutions and private individuals, whether scientific or not. Two years ago, the Council initiated a Bursary Fund for assisting meritorious students, of all ages, who would otherwise be unable to afford the fees for working at the field-centres. During the year a grant of £400 was received from Mrs. F. E. Thornton, widow of the ornithologist C. E. Thornton, who knew and loved the Malham moors, to be invested for this purpose. Grants of £100 for the same purpose have been received from the Thomas Wall Trustees and the Worshipful Company of Grocers, and the steady accretion of this Fund by such and smaller gifts would enable the field-centres to take in each year a number of keen young students who could not otherwise visit them, and who are the most likely to undertake the important advanced work.

Hope for a generous response to this and the more general appeal of the Council for voluntary financial support is encouraged by the degree of co-operation which has already been established between the Council and representatives not merely of the local education authorities but also of the universities and learned societies. In the active and growing amateur and professional membership of the Council, there is room for an increasing number of scientists, who, no matter in what scientific discipline they have been trained, should appreciate the importance of a clear and widespread understanding of ecological problems in this era of critical relations between population and food supply and other natural resources. It may well be that this educational aspect of the Council's activities is even more important than its scientific work; but, on either count, scientists should not be less generous than industry or their fellow citizens in responding to this appeal, either personally or corporately through societies or institutions with which they are connected.

CONIFERS UNDER THE POCKET-LENS CAMERA

Conifers in Britain

An Illustrated Guide to Identification. By B. Alwyn Jay. Pp. 47+136 plates. (London: Adam and Charles Black, Ltd., 1952.) 35*s*. net.

IT is useful at the outset to realize what this book is not. In spite of its sub-title it is not really a guide to the identification of the conifers growing in Britain, in the sense of being a full guide. It does not pretend to compete with such well-known

manuals as Dallimore and Jackson's "Handbook" or Jackson's adaptation of it, for, in any good arboretum, a wide range of conifers would be found which are not even named in this book.

Nevertheless, within its scope, this is an interesting and valuable production and, to anyone who has also dabbled in photography, will be, in many ways, a delight. The volumes of Clinton Baker's "Illustrations of Conifers" are now collectors' pieces; but this book continues and modernizes the tradition. Apart from some pages of script, it is essentially a collection of 136 photographic reproductions of the branchlets from sixty-four different conifers. Except in three cases, each species is represented by a photograph, natural size, of the upper and lower aspects of typical branchlets, followed by one at an eight-fold magnification of smaller suitable zones. It is this latter development, the application of pocket-lens photography to conifer branchlets on an extensive scale, which is new and which is the real value of the book because it has been really well done. Mr. B. A. Jay, being an associate of the Royal Photographic Society, is not a tyro in photography, and he has certainly shown his paces in these records. The typical vegetative features used in identification are all here, perfectly and critically displayed, just as they would appear in strong light under a good hand-lens. To the beginner, examining certain conifers for the first time, these photographs must be an inestimable boon; to the older hand their beauty and clarity yield an unfailing pleasure. If one comments that the reproduction in an occasional plate is not perfect, or that, for example, the two characteristic horny points on the leaf of *Abies firma* might be more distinct, it is because most of the others are so good that one wonders at even such small occasional departures from perfection. Perhaps in his next volume of studies Mr. Jay may be induced to give his photographer readers some details of the technique which has proved so successful in his hands.

The set of photographs illustrating each species is very usefully accompanied by a precise diagnostic description which seems accurate in every case. Introductory to the plates is the separate script giving a key to the genera illustrated, specific keys for those genera such as *Pinus* and *Abies* in which a number of species appear, and a useful table giving for each species brief data on nomenclature, occurrence in Britain and sylvicultural importance. A few flaws were noticed in this script. *Pinus coulteri* appears in the diagnostic key (p. 19) to the species of *Pinus* but nowhere else. *Abies procera* is *Abies nobilis* (p. 27) in the key for *Abies*. *Cryptomeria* and *Sequoia wellingtonia* are both said on p. 15 to bear scale-like leaves similar to those of *Cupressus* and then, in the key to the genera, *Cryptomeria* is separated on the basis of having awl-shaped leaves. The leaves of *Sequoia wellingtonia*, described as scale-like in the key to the genera, are referred to in the description under its plate as awl-shaped. This is a little confusing, especially as the foliage of neither can really be considered cupressoid. On p. 10 *Sequoia sempervirens*, obviously accidentally, is bracketed with *Metasequoia* as having linear leaves opposite or decussate. These, and a few other such points, can of course be readily corrected in subsequent issues, if only by an erratum slip. I regret, however, that there is little in the notes on classification on pp. 16–17 with which I can agree, though I am glad to record that Mr. Jay is not responsible for these pages. The nomenclature used follows the 1949 edition of Dallimore and Jackson's "Handbook". It is pleasant, therefore, to see that here, too, the Sierra redwood is still *Sequoia* and not segregated to the indefensible *Sequoiadendron*, though perhaps not everyone will be happy about the specific name now standard and, apparently, necessarily standard.

But the scope of the book must always be remembered in spite of its many excellences. It only deals with sixty-four conifers, and this deliberate limitation definitely lessens its general range of usefulness. Without question, in an arboretum containing only these sixty-four the veriest novice could with certainty identify each. The beginner, however, meeting types outside the selected sixty-four, would soon find himself at a loss because the diagnostic keys given are only valid for the conifers actually illustrated. Even then the selection seems a little unbalanced. The common ones are here and also those of importance in afforestation schemes as well as some of the less common ornamental forms. But surely there are many conifers more commonly to be met with in Britain and thus more deserving of inclusion in this introductory volume than, say, *Agathis australis* or *Pinus cembroides* var. *monophylla* or even *Abies koreana*? However, this criticism only applies to about eight of the forms included.

The book, therefore, must be taken for what it is—a really valuable and instructive collection of photographs of branchlets of a number of selected conifers, mostly fairly common. The excellence of the photographs, especially those at the pocket-lens level, induces one to hope that Mr. Jay will continue to apply his fine skill along the same lines to give us in the near future companion volumes to illustrate those many other interesting conifers which, even if not common, are at least frequent or occasional in Britain.

J. Doyle

GARDEN FLORA OF HARDY PLANTS IN FRANCE

Flore illustrée des Jardins et des Parcs

Arbres, arbustes et fleurs de pleine terre. Par Dr. P. Fournier. (Encyclopédie biologique, 38, 39, 40.) Tome 1: Fougères, gymnospermes et monocotylédones. Pp. 340. Tome 2: Dicotylédones. Pp. 552. Atlas. 182 plates. (Paris: Paul Lechevalier, 1951–1952.) 3 vols., 11,000 francs.

MANY of those who are interested in practical horticulture would wish for a not too bulky work that will enable them to identify the plants that are commonly grown in their gardens. The work under review furnishes a key for the identification of the families, the genera and some 6,730 species of trees, shrubs and herbs that are grown in the open air in France. A volume of plates provides line-drawings of details of more than two thousand species to illustrate the text. The value of such a key can only be assessed by its extended use, especially by those who do not already know too many of the answers; but it is obvious that, for a large number of gardeners, this will fill a very real need and should often enable the horticulturist to name his plant with a minimum of trouble. However, as in most such aids to rapid identification, the fact that flowers and fruits are too often not simultaneously available is sometimes forgotten.

Naturally, in southern France plants can be grown in the open that would not be hardy in Britain, so

that the inclusion of six species of fuchsia, of several epiphytic orchids or of forty-five different kinds of palm, compared with the single species which is hardy in Britain, causes no surprise. To the British reader, however, the important question is to what extent those species which are hardy in his country are cultivated in France. In the recently published "Gardeners' Dictionary" more than eighty species of *Dianthus* are listed as hardy in Britain, and, of these, twenty-eight are included in the work under notice; of *Cornus*, the French book includes eighteen of the twenty-nine cultivated in the British Isles. So it will be appreciated that a considerable degree of selection has been exercised, and many of the less commonly cultivated species have been omitted. Clearly the author, faced with the choice between the production of a work that would be comprehensive and unwieldy or one that would be relatively convenient to handle but restricted in its scope, has chosen, perhaps wisely, the latter.

It should be added that the illustrative drawings, though often diagrammatic in presentation, are quite adequate for their purpose as aids to identification.

Issued in paper covers at the equivalent of about £11, which presumably includes the third volume of text not yet available, it is to be feared that there will be comparatively few horticulturists outside France who will see their way to buying for themselves a work of this character. E. J. Salisbury

POPULATION CHANGES IN EUROPE SINCE 1939

Population Changes in Europe since 1939

A Study of Population Changes in Europe during and since World War II as shown by the Balance Sheets of Twenty-four European Countries. By Gregory (Grzegorz) Frumkin. Pp. 191. (London: George Allen and Unwin, Ltd., 1951.) 30*s*. net.

SHORTLY after the end of the Second World War the United Nations Economic Commission for Europe began a survey of European man-power. Yet the present cannot be understood without a knowledge of the past, and it quickly became clear that the demographic upheaval caused by the War was largely uncharted and very ill-recorded. M. Gregory Frumkin, formerly editor of the "Statistical Yearbook of the League of Nations" and now a member of the United Nations Secretariat, undertook the heavy task of piecing together the demographic history of Europe for the War period. The result is a scholarly compilation of the main changes in total population of twenty-four European countries for the two periods end-1938 to end-1945, and the succeeding years 1946–47. The U.S.S.R. is excluded from the main account because accurate data are non-existent.

A valuable feature of the work is the author's insistence on a standard treatment for every country. National statistics, based on a variety of definitions and relating to a multiplicity of dates, have been rearranged to conform to a standard pattern. This commendable attack on the difficult problem of international comparability inevitably results in estimation and its attendant errors. Yet these will be of small account compared with the uncertainty which still surrounds the extent of the loss of human life from genocide, and the size of the migratory movements, voluntary and involuntary, which swept across Europe in the wake of the Nazi terror.

M. Frumkin insists on independent estimates of all components of population change. These are: births, deaths (divided into those directly attributable to military operations, mass murders and 'normal' deaths), losses and gains from territorial changes, and the successive waves of migration during and after the War. Official statistics, amended to fit the author's standard form, provide starting and finishing check-points. If the account for any country does not balance, and it rarely did, then one at least of the estimates must be wrong. The major part of the author's research has been the patient examination and reconciliation of the many discrepancies he uncovered. He has avoided residual or balancing items which merely reflect an accumulation of errors in the remaining figures.

The general approach is described in Chapter 2. The next chapter is the core of the work and contains a survey of population changes for each country separately. The whole account is preceded by a brief description of the characteristics of population growth during the 1930's, and concluded by a summary of the changes wrought by the War. One of the more horrifying tendencies of modern warfare is laid bare: "Out of 10 million war losses in countries under Nazi control . . . 8·6 millions related to losses among the civilian population and only 1·4 million were military losses". Not least in interest is the evidence of the remarkable recuperative power of a population. By the end of 1947 the total population of the countries surveyed had overtaken war losses and exceeded the total at the end of 1938 by some four millions.

H. Silcock

LIPID METABOLISM

Biochemical Society Symposia

No. 9: Lipid Metabolism, a Symposium held at the London School of Hygiene and Tropical Medicine on 16 February 1952. Organized and edited by R. T. Williams. Pp. v+102. (Cambridge: At the University Press, 1952.) 13*s*. net.

THIS volume contains the papers communicated in substance to the Biochemical Society's symposium on February 16, 1952 (see *Nature*, 169, 569; 1952). The publication in full of the memoirs then dealt with is welcome, since in each instance a fairly full survey is presented which offers a more-or-less complete picture of each subject considered. The collection, which has been prepared by Prof. R. T. Williams and published for the Biochemical Society in the clear and excellent format common to all the Society's publications, is therefore of value to both students and investigators who are concerned with the problems discussed at the symposium.

The first three communications (by Prof. A. C. Frazer, Dr. R. P. Cook and Dr. J. M. French) deal with the absorption of fat by animals. Prof. Frazer's review of the work of his own school and of others during the past thirteen years on the mechanism of fat absorption gives a picture of the conclusions reached up to the present time. It suggests that the balance of evidence is in favour of his partition hypothesis, which presupposes only partial hydrolysis of ingested glycerides with intraluminar emulsification of glycerides as an important step in their absorption; and that the alternative view of complete hydrolysis

of glycerides to fatty acid and glycerol, followed by re-synthesis in the intestinal cell to phospholipids (as an essential intermediate), is no longer tenable.

The contributions of Dr. G. Popják and Dr. S. J. Folley on the synthesis of fatty acids in animals, especially in their mammary glands, from acetate (or from glucose via acetate or pyruvate) will receive much notice, since the recent important studies of both authors in this field are collected and discussed in relation to results obtained by other workers. It is of great advantage to have the results which have been disseminated in a large number of individual papers in the scientific journals brought together by two of the most prominent investigators of this subject. Dr. Popják's review concerns the evidence, based on work with radioactive acetate, of synthesis of fats in general from small (two-carbon) molecules, while Dr. Folley's is more specifically devoted to the biosynthesis of milk fat in ruminant mammals. The two articles together give a complete account of the subject as it stands at present.

Dr. A. L. Lehninger gives in some detail an account of recent work by himself and his colleagues on the mechanism of the enzymatic oxidation of fatty acids. The discussion includes sections on the properties of the fatty-acid oxidase system of animal tissues, on the mechanism of acetoacetate formation and oxidation, and on the significance of recent work on fatty-acid oxidation and synthesis in extracts of *Clostridium kluyveri*.

The final paper, by Dr. H. M. Sinclair, deals with the fatty acids (linoleic, linolenic, arachidonic) essential to growth and their relation to pyridoxine. This very interesting contribution, which merits careful study, brings out an analogy between deficiency of essential fatty acids and deficiency of pyridoxine. It is suggested that failure of growth in essential fatty-acid deficiency may be connected with inability to form the phospholipids necessary for cell membranes, and also that the essential poly-unsaturated acids may be concerned in controlling the water retention of animal tissues.

It is to be hoped that this, necessarily brief, notice of the contents of the volume may serve to indicate its usefulness to all interested in the role of lipids in biochemical processes.

COSMIC RAYS AND THE CLOUD CHAMBER

Cloud Chamber Photographs of the Cosmic Radiation

By G. D. Rochester and J. G. Wilson. Pp. viii+128. (London: Pergamon Press, Ltd., 1952.) 70*s*.

THE authors of this book, Dr. G. D. Rochester and Prof. J. G. Wilson, are to be congratulated on its production; in bringing together in one volume a very fine collection of photographs, they have paid worthy tribute to the part the cloud chamber has played in revealing the nature and associated properties of the fundamental particles which are found in the cosmic radiation. To each photograph (the total number of which is one hundred and twenty-three) the authors have prepared a most useful synopsis giving not only the details of the actual chamber and the geometry of the accessory equipment such as position and size of lead plates, but also an analysis of the physics of the event in question; this includes both the results of the measurements made upon the tracks and a discussion of the resulting interpretation of the event. It cannot be stressed too strongly that all nuclear physicists will benefit from a study of the photographs whether or not they are versed in the technique of the use of expansion chambers. It is true that to those who are so versed the book will be of extra value in that it shows the results obtained from chambers covering a great range of sizes, operating pressures, etc.; but the outstanding merit of the book is the fact that it describes and discusses, in an interesting manner, real fundamental physics. The quality of the reproduction of the photographs is excellent and is immediately impressive.

The photographs are grouped in six sections. Section 1 is entitled "Technical Features of Operation" and illustrates the process of formation of drops, the efficiency of condensation upon ions, the effects of turbulence and contamination within a chamber, and other features. Section 2 deals with electrons and cascade showers, and the first few plates show the tracks which revealed the existence of the positron and the cascade process; photographs of extensive showers show not only the presence of cascade particles, but also penetrating particles together with nuclear interactions associated with such showers. Section 3 is concerned with the existence and subsequent decay of the μ-meson; a most important group of photographs demonstrates the way in which the mass of a particle may be determined from momentum and range measurements, and includes an indication of the nature and magnitude of the uncertainties involved.

Nuclear disintegrations and interactions of secondary particles form Section 4, which covers reactions observed in multi-plate chambers (for example, of carbon and lead), as well as stars produced in the gas of the chamber.

The photographs which have made it necessary to postulate the existence of charged and uncharged V-particles are shown in Section 5. The interpretation of these photographs is clearly discussed and well illustrates the vital contribution to physics which may be contained in only a few photographs. Section 6 consists of a single photograph showing the track of a primary cosmic-ray particle in a chamber operated at an altitude of 95,000 ft.; this photograph is indeed a tribute to the skill and ingenuity of the research worker, as well as the reliability of the expansion chamber.

It is to be hoped that the authors intend to keep the material of the book up to date either by appropriate revision or by the publication of a second volume when sufficient progress has been made. On this assumption, a few minor suggestions may be offered. In the technical descriptions of the chambers, more details of the magnets, lamps, cameras and general illumination geometry would be useful. In the case of experiments where the counter selection is complicated, a simple schematic diagram would be valuable; in the first section dealing with technical operation of chambers, more 'faults' should be included showing the different effects of intrinsic chamber faults (for example, inadequate temperature control), control faults, and illumination and/or recording faults.

The price of the present volume is rather high, but it must be appreciated that, where it is required to have an overall reproduction of such a high standard, a high cost is unavoidable. J. R. ATKINSON

Management and Conservation of Vegetation in Africa

A Symposium. (Commonwealth Bureau of Pastures and Field Crops, Bulletin No. 41.) Pp. 97+14 plates. (Farnham Royal: Commonwealth Agricultural Bureaux, 1951.) 10*s*. 6*d*.

THE title of the symposium which this book records is perhaps liable to lead to unfulfilled expectations. There is relatively little emphasis on management and a lack of data on conservation. The emphasis is rather on the need for vegetation surveys, which, however desirable in themselves, as a record of what now exists, can alone do little, if anything, to arrest the losses we all deplore. One of the great needs in Africa concerns the controversy that still rages as to whether to burn or not to burn, and I recently heard in South Africa both views defended with great vigour. Even where there is a measure of agreement that some burning is desirable, or at least unavoidable, there are few precise data as to when and how often to burn so as to attain the optimum result.

The first of the contributions included in this volume is by J. P. Scott, who does in effect consider, all too briefly, the actual principles involved in conservation. G. C. Edwards, writing on the vegetation types of East Africa, stresses the need for a changed system of agriculture based upon the ecological conditions, of which the native vegetation is the best indication, and he advocates the value of a temporary ley as the best means of building up and conserving soil fertility. H. J. Rensberg strikes a similar note for the Tanganyika area. An interesting account of the ecology of savanna in Nigeria is provided by R. N. J. Keay, while A. Fogie gives a summary of the forest reservation in the Gold Coast. There are also brief accounts of what is being attempted in the Sudan and Sierra Leone.

With such a title, however, one might have anticipated some account of the experimental results achieved in various areas, such as those carried out at the experimental station at Frankenwald. Nevertheless, with all its limitations, this is a book that all those interested in such problems will find of value.

E. J. Salisbury

Statistical Methodology Reviews, 1941–1950

Edited by Oscar Krisen Buros. Pp. xi+457. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 56*s*. net.

THIS is the third compilation issued by Prof. O. K. Buros, the last being published in 1941. It assembles in one large well-printed volume the reviews of books on statistical methodology published in English during the decade 1941–50 and contains 842 review excerpts from 112 journals covering 342 books. There are, in addition, useful indexes of periodicals, publishers, titles and authors' names, as well as a classified index to the books themselves.

A would-be student of statistical methods will find it useful to consult this work to see what books have been published and what reviewers think about them. But for statisticians and reviewers of any class of scientific book the work will have a wider appeal, not to say a considerable entertainment value. It is a fascinating study to compare a number of reviews of the same work and to observe the variation of opinion expressed in them. Review editors will also find much here of help in framing their general policy. One of Prof. Buros's objects in embarking on this work some fifteen years ago was to improve the quality of reviews, and a comparison of this book with its predecessor, the "Second Yearbook", indicates that he has been partly successful. It is to be hoped that he will continue to find support for this useful enterprise.

Understanding Heredity

An Introduction to Genetics. By Richard B. Goldschmidt. Pp. ix+228. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 30*s*. net.

THIS book is intended for the educated layman who wishes to acquire an elementary knowledge of genetics. Its aims are to give a broad outline of the subject and of its implications in biology and in everyday life, and to stimulate enough interest to make the reader eager to attack some more advanced treatise. There is no denying that to many it will come somewhat as a disappointment. From Prof. R. B. Goldschmidt, who has been constantly and successfully ahead of the times in criticizing the shortcomings of accepted genetical concepts, one would have expected better. The very necessary sacrifices required by simplification and conciseness do not justify the omission of the salt and pepper, that is, the problems still unsolved and the wider vistas opened up. As an addition to the number of books giving in a simplified form the main facts and ideas of genetics, it will have its value.

G. Pontecorvo

Substances naturelles de synthèse

Préparations et méthodes de laboratoire. Collection publiée sous la direction de Dr. Léon Velluz. Vol. 4. Pp. 165. (Paris: Masson et Cie., 1952.) 1800 francs.

VOL. 4 of this series follows the same plan as the earlier volumes (see *Nature*, **169**, 169; 1952). The more important and larger part of the book gives experimental details, taken from recent chemical literature, for the laboratory preparation of certain biologically important substances.

The preparations described are *d*-pantothenic acid (Stiller, Harris, Finkelstein, Keresztesy, and Folkers, *J. Amer. Chem. Soc.*, 1940), adermine (Harris, Stiller, and Folkers, *J. Amer. Chem. Soc.*, 1939), riboflavine (Karrer and Meerwein, *Helv. Chim. Acta*, 1936), testosterone (Serini and Köster, *Ber.*, 1938), and *dl*-α-tocopherol (Smith and Sprung, *J. Amer. Chem. Soc.*, 1943). Each synthesis is prefaced by a short introduction and is followed by a lengthy series of notes on related processes, etc.—for example, analogues of pantothenic acid, β-alanine, the phthalimide synthesis, elimination of hydroxyl from aromatic heterocyclic compounds, ethoxyacetylacetone, 3 : 4-xylidene, amino-saccharides, etc. In several cases, alternative syntheses are discussed.

The second half of the book contains lengthy sections on cyclizations leading to derivatives of pyridine and on adsorption chromatography, including practical notes on the preparation of adsorbents. There are finally some tables relating metric to other measurements, °F. to °C., and lb./sq. in. to kgm./sq. cm. The price of the book is very high considering that all the factual information is readily available elsewhere. If many of the notes and addenda were omitted, these volumes would lose little of importance and could be published at a lower price.

W. Baker

UPWELLING IN THE BENGUELA CURRENT

By RONALD CURRIE
National Institute of Oceanography

THE Benguela Current is one of the major features of the circulation of the South Atlantic Ocean. Extending northwards along the African coast from the neighbourhood of Cape Town to about lat. 15° S., the current is a region of upwelling of relatively cold water rich in nutrient. The resultant high fertility of the surface waters gives rise to great production of planktonic plants and animals, while the presence of the cool water has extensive climatic effects. In such features the Benguela Current has much in common with the Peru Current, which was surveyed by the R.R.S. *William Scoresby* under the Discovery Committee in 1931. When this ship visited South African waters in 1950, two surveys of the Benguela Current were carried out, first in March and again in September–October. The programme for the voyage was planned by Dr. N. A. Mackintosh, and it included these surveys not only to allow a comparison to be made with conditions in the Peru Current but also because such regions are specially favourable to investigations on the production of life in the sea.

The German Atlantic Expedition (in the *Meteor*) was the first to study the current extensively, and it enabled Defant[1] to produce the most comprehensive account of it so far. The *Meteor* observations, however, were relatively widely scattered in space and time; they provide a broad picture of the current and its effects in relation to the South Atlantic as a whole, but leave much to be learnt of the fluctuations of the current and the mechanism of upwelling. Hence the *William Scoresby*'s work included lines of closely spaced 'stations' off the South West African coast (Fig. 1). Limited time restricted them to the coastal region, but these intensive observations covered the area which, in view of Defant's findings, was most likely to be of interest.

As the surface currents of the eastern side of the South Atlantic are principally wind-driven systems, to understand them one must have a knowledge of the prevailing winds. Over the South Atlantic the surface winds blow out anticyclonically from a large region of persistent high pressure, and the component blowing over the eastern part of the ocean is the South-East Trade Wind. Near land, however, the trade wind develops a landward component which varies with the fluctuations of pressure over the continent, this in turn resulting from the great heating and cooling which the land mass undergoes. This landward wind or sea breeze thus shows a marked diurnal variation, and frequently attains considerable force, blowing from almost due south in lat. 30° S., and veering to south-west northwards along the coast.

It is not surprising, therefore, that the sea surface currents should show considerable irregularity in the coastal region. Defant, from an analysis of the Dutch current observations, found that inside the relatively constant drift current produced by the South-East Trade, the coastal currents were extremely irregular, and were separated from the drift current by a "one-sided line of divergence". Further, Defant showed that the region of strong negative temperature anomaly was confined to the coastal current.

Distribution of temperature and salinity. The accompanying charts (Fig. 1) show the distribution of surface temperature, compiled from the 'station' observations and supplemented by the data from a distant-reading thermograph with which the ship was equipped. On both surveys, the most outstanding feature of the distribution was the pronounced irregularity of the isotherms. Whereas the isotherms of the open ocean run more or less latitudinally, in the

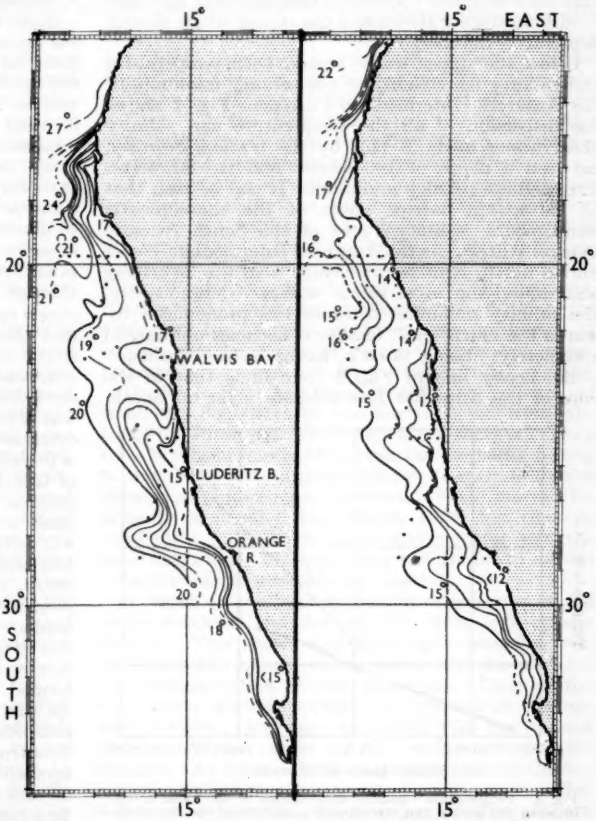

Fig. 1. Sea surface isotherms (*a*) during March, (*b*) during September–October 1950. Isotherms are drawn for each whole degree C. Stations are shown by dots

Benguela Current they run approximately parallel to the coast. The existence of the interlocking tongues of relatively cool and warm water suggests that the upwelling of cool water to the surface occurs not everywhere, but at separated points along the coast. The distribution of salinity follows a pattern similar to that of temperature, the lower salinities occurring in the cool water against the coast. Offshore, one finds that, while the temperature rises relatively steadily, there is a sharp contrast between the salinity of the inshore waters (*c.* 35·00‰ or less) and that of the offshore waters (*c.* 35·20‰). It appears, therefore, that there are two distinct surface waters, generally with a fairly sharp boundary between them, although in places mixtures occur. The inshore water generally has similar properties to the water at subsurface depths farther offshore.

Examination of the vertical distributions of temperature and salinity shows that on both surveys a well-developed homogeneous surface layer was present offshore. This was separated from the underlying water layers by a strong temperature discontinuity. Inshore, however, there was evidence of considerable variation: during the first survey no such homogeneous layer was detected, and strong heating had apparently taken place on the surface; but during the second survey, there was a thin homogeneous surface layer overlying a weak discontinuity. This difference indicates the contrasting effects of the calm conditions during March and the strong winds during September–October.

Below the upper water layers, both temperature and salinity fell steadily to the salinity minimum of the Antarctic Intermediate Current. Fig. 2 shows the dispersion of all the temperature and salinity observations made in 1950 by the *William Scoresby*, between a depth of 100 metres and the Antarctic intermediate salinity minimum. It can be seen that all lie within narrow limits of the characteristic temperature – salinity curve of the South Atlantic Central Water[2]. As the Antarctic Intermediate Water moves north, it mixes vertically with the overlying and underlying more saline waters. Consequently, the salinity minimum becomes less pronounced towards the north until, finally, it becomes obliterated completely. Using Wüst's 'Kernschichte Methode'[3] —the heavy line in Fig. 2—one finds that in the core of the Antarctic Intermediate layer off South-West Africa only 50 per cent of the original water type remains and this at a depth of more than 600 metres. Since our data indicate that the upwelling does not extend much below 300 metres, it is only a relatively small proportion of Antarctic intermediate water which is subject to upwelling.

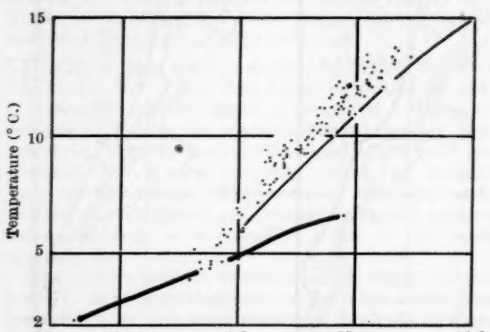

Fig. 2. Temperature – salinity relationships of the water layers between 100 metres and the salinity minimum of the Antarctic Intermediate Water. The heavy line shows the relationship of the core of the Antarctic Intermediate Water from the source (left) to the northern limit (right) after Wüst (ref. 3). The thin line is the line characteristic of South Atlantic Central Water (Sverdrup, ref. 2)

The strong indications of active offshore transport of surface water during September–October, compared with the more quiescent conditions found in March, demonstrate the difference between active upwelling and the more advanced stage of mixing of previously upwelled water. The dynamical principles of the movement of a northward-flowing current in the southern hemisphere require that the more dense water should lie in the east side of the current, and upwelling may purely be a lifting effect within the current.

The wind records for the periods preceding the two surveys leave no doubt, however, that the great difference between the surveys was a direct result of the prevailing wind conditions. No detailed observations of the wind over the sea are available; but it is known that the trade winds were much stronger during September–October than during March. In addition, wind records from three South-West African shore stations show that whereas the sea-breeze was light and variable during February and March, it would have been conducive to a longshore transport of surface water during September–October.

Since there are no direct observations of current, the anomalies of dynamic depth of the isobaric surfaces have been calculated, with reference to the 600-decibar surface. Although in a region where vertical movements are important this method must be used with much caution, the inferences appear reasonable, and show similar features to findings in other regions[4,5]. During March, the computed currents show a general movement to the north with a rather weak southerly movement inshore, reaching to about Luderitz Bay. During September October, a series of horizontal eddies was present inside a much stronger northerly flow. Vertical sections through the eddies indicate that the sea surface slopes upward from the coast to a line of convergence, and then falls into a trough, and farther offshore slopes upwards again. On some of the sections the observations did not extend far enough seawards to show this trough, although the line of convergence was always well marked. Since the sea surface must eventually rise towards the open ocean, however, it is probable that such a trough was there. An example of this distribution is given in Fig. 3. Sverdrup[4] has pointed out that in a region such as this (Sverdrup deals with the Californian coast), strong convection will develop between the more dense water upwelling and being transported offshore and the light offshore water, sufficiently well defined to be regarded as a boundary. Seawards of this boundary there is a tendency for divergence within the offshore water due to the increasing effect of the wind on the surface. A circulation of two vertical cells would thus be formed, separated by a strong convection current. As the boundary moves offshore, there must be a compensation flow into the inner cell, and this Sverdrup defines as the upwelling movement, the upward movement above being part of the cellular circulation. Superimposed upon this vertical circulation must be a horizontal eddy formation.

It appears, therefore, that the circulation is somewhat more complex than Defant could deduce from the data at his disposal, and the 'one-sided divergence'

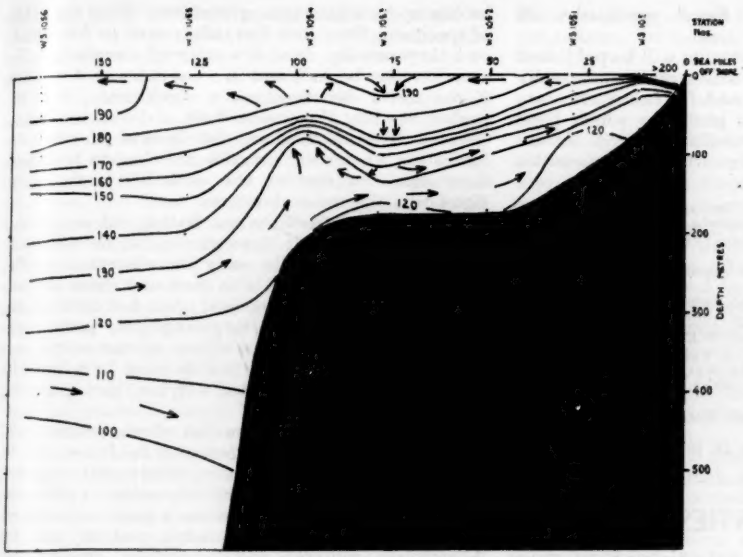

Fig. 3. Vertical section normal to coast in lat. 28° 40′ S. showing isosteres and probable direction of water movement in the vertical plane. (Isosteres are the lines of equal specific volume expressed as the difference × 10^5 from the specific volume of sea water of 35 parts per 1,000 salinity and 0° C. at the same pressure)

seems to be an eddy-like system rather than one long continuous divergence line. The size and stability of these eddies must depend upon the intensity of the forces which produce the upwelling, and about which there is still little precise information. The distance to which they persist must be variable and governed by the variability of the external forces. Whether the eddies are consistently formed in any particular regions is difficult to say without more intensive observations, although the continuous low temperatures and high productivity of the region around Luderitz Bay (*c.* lat. 26° S.) suggest that this may be one region where eddies often form.

Although no significant temperature – salinity differences occur in the underlying water layers (Fig. 2), there is a great depletion of dissolved oxygen and enrichment of phosphate close to the continental slope. This layer of oxygen minimum and phosphate maximum is similar to that found extensively over the equatorial regions of the ocean. It probably results from a balance between the rates of decomposition of organic matter, and the turbidity and diffusion rates between those layers and the neighbouring water masses. Upwelling brings some of this poorly oxygenated, highly nutrient water into the euphotic zone. Although this will favour great phytoplankton production in the surface layer, the low oxygen content will help the effects of local decomposition of organic matter to maintain almost anaerobic conditions in the shallow reaches of the continental shelf.

The inorganic phosphate content of the upwelled water is very high (> 2·0 mgm. atoms phosphorus/m.[3], about four or five times the present normal winter maximum of the English Channel[6]), in contrast to the almost complete absence of phosphate in the offshore surface waters. Local maxima and minima occur, as the oxygen shows varying degrees of saturation with the varying abundance of the phytoplankton populations. It was found that the phosphate content on the shelf was often greater than that in the upwelling water. This may be due to intense local regeneration from decaying plankton.

During the second survey an attempt was made to measure the extent of the 'azoic zone', a region of reducing mud[7], and this was found to cover a larger area than was previously supposed. A series of Baillie rod soundings revealed that it extended, at least in patches, between depths of 50 and 150 metres, for about 400 miles north of lat. 25° S. The sediment, a dark green diatom mud, is populated with sulphate-reducing bacteria; their production of hydrogen sulphide must further reduce the oxygen content of the local shelf waters. The oxygen depletion was most marked near Walvis Bay: during March the water with less than 1·0 c.c. oxygen per litre extended to the sea surface; during September–October, however, these low concentrations were confined to the lower third of the water column. In the determination of the oxygen, steps were taken to eliminate the effect of large quantities of reducing substances and organic matter.

At times, the concentration of hydrogen sulphide becomes so high that the gas is actively evolved from the sea surface. As this frequently occurs at the same time as mass mortalities of marine organisms, some authorities have attributed the mortality primarily to an oxygen deficiency. Brongersma-Sanders[8] has, however, preferred to consider the effects of toxins released from mass outbursts of certain dinoflagellates as being the primary cause, principally on evidence from other similar regions.

Dr. T. J. Hart has found 3,000–5,000 cells/ml. of small dinoflagellates in samples collected from discoloured water patches during these surveys. They have not been finally identified, but probably belong to one of the several genera known to include species capable of producing toxic effects. Small mortalities actually occurred during March 1950, but there is insufficient evidence to show which factor was the more important. The effect may well be due to several unfavourable factors acting together.

A paper on preliminary results of analyses of the other plankton samples by Dr. Hart will appear shortly. This shows that good agreement between the plant and animal distributions and the physical and chemical data is often apparent. Thus all the very heavy diatom populations occurred in the upwelled water; and they coincided with the highest supersaturation values of the surface water with oxygen. At times, dense concentrations of Chætocerids imparted an olivaceous colour to the upwelled water, in contrast to the transparent blue offshore water. The scanty phytoplankton of the latter included a relatively high proportion of the diatom *Planktoniella sol*, which seems a useful indicator of intrusions of offshore water towards the coast, as

Gunther and Rayner[9] had found previously, off Peru.

The physical and chemical results will be published shortly by the National Institute of Oceanography in the 'Discovery' Reports, and further studies are being made of some of the problems which have been mentioned with the particular object of obtaining evidence about the factors which affect oceanic productivity.

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[2] Sverdrup, H. U., *et al.*, "The Oceans" (Prentice-Hall Inc., New York, 1946).

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[4] Sverdrup, H. U., *J. Mar. Res.*, **1**, 155 (1938).

[5] Defant, A., *Dtsch. Hydrogr. Z.*, **5**, 69 (1952).

[6] Cooper, L. H. N., *J. Mar. Biol. Assoc. U.K.*, **23**, 181 (1938).

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[8] Brongersma-Sanders, M., *Verh. Akad. Wet. Amst.*, 2nd Sect., DL., **45**, No. 4 (1948).

[9] Gunther, E. R., Discovery Reports, **13**, 107 (1936).

MAGNETIC PROPERTIES OF ROCKS

THE significance of the natural remanent magnetism of igneous and sedimentary rocks has not yet been determined. On one hand, there is the hypothesis that the direction of magnetization can be interpreted in terms of a widely varying magnetic field and, on the other, that the adverse polarizations arise from intrinsic properties of the rock assemblage. These aspects formed the main theme of a geophysical discussion at a joint meeting of the Royal Astronomical Society and the Geological Society, held in London on January 23, with Prof. E. C. Tilley (Department of Mineralogy and Petrology, Cambridge) in the chair. Prof. Tilley noted that the magnetic properties of rocks have also been found to be of considerable value to geologists by yielding magnetic anomalies reflecting the distribution of certain rock-types, the measurement of such anomalies culminating in aeromagnetic surveys.

In opening the discussion, Dr. J. M. Bruckshaw stated that the value to the geologist of the results he proposed to discuss would be controlled by their final interpretation. Of recent years the study of permanent rock magnetism has been intensified, and Dr. Bruckshaw's interest was first aroused by the discovery that the tholeiite dykes of northern England are magnetized in a direction opposite to that of the present earth's field. Since these dykes represent the final phase of igneous activity centred upon Mull, it was an obvious step to examine the rocks in the earlier phases of this activity. The earliest phase was the quiet extrusion of a sequence of lava flows followed by the cyclic intrusion of basic and acid ring dykes and cone sheets about a centre which migrated twice towards the north-west. The final phase was the production of the north-west dyke swarms, of which the tholeiite dykes were the last members. Since a known time-sequence of events exists, it is possible to sample rocks of different periods and, in the present case, some of the basalt flows, some early basic intrusions, the ring dykes of Glen More and Loch Bà and some of the north-west dykes were examined. After a rock has been polarized, many factors may tend to modify it, and some influences will result in random magnetization. For example, a partially solidified lava-flow might be broken up by a further supply of lava. Thus a number of specimens from each formation must be examined, and they usually show a scatter of directions. Inspection may be sufficient in some cases to determine if the mean direction has a significance, but the probability that the observed set of directions can be selected from a random distribution is used for indicating what weight can be attached to the mean direction; the smaller the probability the more significant the mean direction.

Using those formations associated with significant directions, the basalt flows proved to be adversely magnetized and also the early basic intrusions. The more acid ring dykes of Glen More and those of Loch Bà were normally magnetized; but a dolerite dyke, earlier than the Loch Bà granophyre, proved adversely magnetized. The dykes of the north-west swarm were normal, and to this must be added the adverse phase of the tholeiite dykes, giving a total of three adverse phases.

The large observed intensities of magnetization in relation to the earth's magnetizing field can only be explained in terms of thermoremanence acquired during the initial cooling, the only occasion when the present rocks were at the necessary high temperature. If this is accepted, the amazing stability of this polarization follows; and laboratory observations support this conclusion, the coercive force of the rocks being comparable with that of modern magnet-steels. In all respects the rocks exhibited ordinary magnetic properties under a variety of conditions and, in particular, acquired normal polarization when cooled in the earth's field. It would thus appear that the simplest explanation of the facts is a number of reversals of the earth's magnetic field in the past, a suggestion to which there are no theoretical objections.

Mr. K. M. Creer pointed out that the main evidence on adverse magnetization comes from igneous rocks, which are magnetized either normally or at 180° to the normal direction. Although there are no theoretical objections to a reversal of the earth's polarity, other explanations of adverse magnetism are possible, such as those suggested by Néel. One of these assumes a constituent having a spinel structure in which two sub-lattices exist, one tetrahedral and the other octahedral. The spontaneous magnetic vectors associated with the sub-lattices have opposite directions and, in suitable conditions, the resultant magnetization would change sign with temperature, thus allowing adverse polarity. This property of imperfect antiferromagnetism is not known. Another process involves two magnetic constituents with widely differing Curie temperatures. On cooling, the constituent of higher Curie point is first magnetized and produces a demagnetizing field. Due to its large negative temperature-coefficient, the initial intensity grows rapidly and the demagnetizing field ultimately exceeds the original field at the Curie point of the second constituent, which becomes adversely magnetized. The ferromagnetic constituents must occur in aggregates of high local concentration.

Mr. Creer recorded that a hypersthene hornblende dacite discovered by Nagata does exhibit adverse magnetization when cooled in a weak field. From it, two magnetic constituents have been separated by Dr. G. D. Nicholls, of the University of Manchester. One (probably magnetite) behaves normally, but the other shows reversed thermoremanent magnetism. He suggested that the normal behaviour of naturally

adversely polarized rocks in the laboratory could be attributed to the rapid rate of cooling, when the components required by Néel do not have time to evolve.

Finally, Mr. Creer considered the evidence of sediments which, on Néel's theory, should not possess inverted magnetism. In the Appalachian Mountains, adversely magnetized Silurian sediments are interbedded with similar but normally magnetized sediments, and these are contemporary, as revealed by the presence in both sets of ostracods of short-time duration, with flat-lying and normally magnetized sediments outside the geosyncline. Thus, any field reversal must have been of a local character, and the reversed sediments in the geosyncline may be the result of a complex history during the mountain-building orogeny. Certain physical differences between the sets of sediments suggest a second interpretation that the polarization of the geosynclinal sediments is stable, but in the flat-lying beds it has, on the whole, followed the subsequent changes in the earth's field. In fact, the absence of any widespread reversals in sediments may be due to instability. Graham's experiments on sediments over a wide time-range show that the most frequent direction of magnetization agrees with a normal dipole field, while conglomerates, which should exhibit random magnetization of the pebbles, show a systematic direction agreeing closely with the present field.

The testing and use of magnetic-survey methods by H.M. Geological Survey and Museum was outlined by Dr. A. F. Hallimond. The problem of the correlation between the observed anomaly and that computed for the structure was initially examined in 1929 by a magnetic survey over the Swynnerton Dyke in Staffordshire; but certain aspects of the interpretation of the field observations proved difficult, since the anomaly due to the splitting of the dyke into two branches gave results similar to that over a dyke with concentrations of magnetite near its flanks. In the simpler cases, however, the observations conformed with theory. Later work over the Lornty Dyke at Bairgowie in Perthshire gave a totally different anomaly from that predicted on the basis of its induced magnetism due to abnormal permanent magnetism. Just before the Second World War, it was demonstrated, in association with Prof. J. T. Whetton, that shallow deposits of weakly magnetic hæmatite could be located by their associated magnetic field. Among others, investigations were carried out over the Brockhill Dyke (Worcestershire) and also in Teesdale over faults in the Whin Sill. The former resulted in the tracing of the extensions of the dyke to the east and west, but estimates of width were rendered difficult because of the appreciable width of the adjoining, and magnetically altered, sediments. Two well-defined faults were followed in the Whin Sill and, in addition, observations over two outcrops, with strikes roughly parallel to and at 45° with the magnetic meridian, permitted the rough resolution of the permanent and induced intensities. The measurements were compatible with an induced polarity based on a susceptibility agreeing with direct observation, together with a horizontal permanent intensity directed approximately due south. The value of magnetic observations as an aid to geological investigations has been fully confirmed by the tests.

Mr. J. Hospers stated that his experiments support the suggestion of a reversed field, rather than that of some property of the rock, to account for adverse magnetism. In Iceland the examination of historical flows between A.D. 1766 and 1948 gives a mean direction of magnetization making an angle of 7° with the present field and 1° with an axial dipole field, and post-glacial flows, between two and six thousand years old, have a mean declination of 1·1° and a dip of 73·8° downwards, very near the dipole field. On the other hand, Early Quaternary flows, of a million years old, have a mean direction making an angle of 8° with the opposite direction of the present field. Below these there is a zone of normally magnetized Tertiary lavas followed by zones of alternate adverse and normal magnetization. The picture revealed is consistent with the idea of a sequence of field changes, occupying about ten thousand years, followed by a period of steady conditions, either normal or adverse, for some half a million years. It was emphasized that the polarization of sediments between the flows conforms with that of neighbouring flows.

This conclusion is supported by the behaviour in the laboratory of rock specimens when heated and cooled. A rock, possessing adverse magnetization assumed to have been acquired by Néel's two-component mechanism, when heated should show a reduction in intensity as the temperature approaches the lower Curie point of the two constituents and, at some temperature just below this critical point, the reduced adverse polarization should be balanced by the normal polarization of the constituent of high Curie temperature. At the lower transition temperature the normal polarization only would operate, and this would finally fall to zero at the higher Curie point. Thus, the curve of intensity against temperature should show a reversal of polarity, a behaviour which was, in fact, observed for the dacite discovered by Nagata. Both normally and adversely magnetized specimens from Iceland, however, exhibit a monotonic fall to zero with increasing temperature, with no evidence of a reversal. Thus, Néel's two-component mechanism cannot apply. Some curves suggest two similarly magnetized constituents of differing Curie temperatures. On cooling in the laboratory field, each specimen recovers its polarization, the cooling curve matching closely the heating curve, a behaviour consistent with the hypothesis of a field reversal.

Prof. Tilley read a contribution from Prof. A. F. Buddington (Princeton University) in which some extensive negative anomalies, revealed by an aeromagnetic survey of the north-western Adirondacks, were discussed. Specimens of the gneisses, with which these anomalies are associated, possess inverse polarization in all cases, and this appears to be related to the ilmeno-hæmatite or titaniferous hæmatite in the rocks. The literature shows the presence of hæmo-ilmenite, titaniferous maghæmite and other similar minerals in rocks possessing adverse magnetization, and the general conclusion is that these minerals, with abnormal magnetic properties, are responsible for the phenomenon. The fact that magnetite, contemporary with these, often possesses normal polarity adds weight to this conclusion. No inference concerning the earth's magnetic field can thus be made until the possible significance of these minerals has been ascertained, the identification of the minerals requiring X-ray, chemical and microscopic examination.

The general discussion was opened by Sir Lewis Fermor, who described some of his early experiences

in the Central Province of India during 1906, following the discovery that certain manganese minerals were magnetic. A dip needle gave very different readings over manganese ores and over the adjoining gneisses and schists. Due to a defect in the instrument, a systematic survey was not made and the observations were not published. Nevertheless, it was of interest to note that the Geological Survey of India had employed successfully the magnetic method in the search for manganese. Referring to the production of adverse magnetization by the processes suggested by Néel, Dr. S. A. Vincenz stated that the first need not be discussed since no such substance is known; but the second process is feasible. The latter is based upon the presence of two constituents, of differing Curie points, and their concentrations in aggregates or "amas". Using the formula developed by Néel and the observed properties of the Mull rocks, the required concentration in the aggregates can be determined. For the lavas and the olivine gabbros, these prove to be 42 per cent and 58 per cent, respectively, and he asked if there is any evidence for a distribution of ferromagnetic minerals in concentrations of this type. Dr. Vincenz also stated that the Swynnerton Dyke possesses remanent magnetism perpendicular to the present field, and similar results have been observed in some Tertiary Welsh dykes. It was pointed out by Dr. H. Manley that only one rock shows adverse magnetism in the laboratory compared with the many hundreds which behave normally.

A remarkable anomaly, associated with a dolerite sill in New South Wales, was described by Mr. A. Day, in which comparable positive and negative centres occur. As titanium is found in the rock, he suggested that a microchemical analysis for titanium in the magnetite of abnormally magnetized rocks might be useful. A similar case in the Allard Lake District, Quebec, was cited by Prof. D. Williams, where massive ilmenite-hæmatite gives negative anomalies but disseminated ore gives positive anomalies. A plea for the examination of the accessory minerals was made by Dr. W. Bullerwell, who indicated that, in Mull, the acid rocks are all normally magnetized. He inquired if their magnetism is less stable than that of the basic rocks, but was informed that their behaviour does not suggest this. On this point Dr. J. Sutton said that valuable data might be obtained from the mixed acid and basic formations of Mull. Replying to a further question by Dr. Bullerwell, Mr. Hospers stated that his suggested time for a change in the field was not based on theory but on observations of consecutive lava flows.

Mr. F. Lowes showed that Graham's argument, repeated by Mr. Creer, which is based on two oppositely magnetized deposits that are contemporary on the basis of their fossil content, does not condemn the idea of a field inversion. A fossil may persist for a million years—a period sufficient to embrace a number of reversals. The discordantly magnetized Welsh Dykes may represent a period of change. Mr. R. Hide pointed out that sedimentary rocks might show the secular change in the past, and the direction of drift during a period of reversal would be an important factor in sustaining or condemning modern theories of the main field.

Summarizing, Prof. Tilley said that many outstanding questions still remain and further data are necessary on sediments and igneous rocks. In particular, a knowledge of the accessory minerals is essential.

J. M. Bruckshaw

OBITUARIES

Prof. Philipp Ellinger

Philipp Ellinger died in London on September 12, 1952, after a long and painful illness. He was born in 1887 in Frankfurt am Main, where he spent his early years before proceeding to Munich to study natural sciences under von Bayer and Roentgen. He took the D.Phil. degree in chemistry at Greifswald under von Auwers in 1911, and passed on to Heidelberg to study medicine and finally graduated D.Med. in 1913. During the First World War he served as a medical officer in the German Army and returned after the cessation of hostilities to Heidelberg, where he occupied successively the position of assistant, lecturer and deputy director in the Pharmacological Institute there and served under three distinguished pharmacologists, Gottlieb, Wieland and Heubner. Towards the end of 1931 he was called to the chair and directorship of the Pharmacological Institute at the Medical Academy of Düsseldorf. By 1933, however, the political situation in Germany rendered his position untenable, and he found refuge in Britain, where, at the Lister Institute, he took up his research problems again and remained until his retirement in June 1952.

Ellinger's early work was largely in the field of toxicology; but by the time he came to Britain he had already turned to physiology, had published important work on renal function and had invented a technique for intravital microscopy which employed fluorescent dyes. With Koschara in 1933 he worked on flavin pigments which he isolated from whey, and thus he contributed materially to the discovery and identification of lactoflavin (riboflavin) as a member of the vitamin B complex and helped to establish the presence of this biologically important material as a constituent of Warburg's yellow enzyme. In 1937 he visited Egypt on behalf of the Medical Research Council to study pellagra, and returned to complete his investigations in 1938. During the second visit he became seriously ill and never fully recovered his normal health in after-years. As a result of the studies carried out in Egypt he concluded that the occurrence of pellagra resulted from two concomitant but independent factors. First, that a condition of latent pellagra arose from malnutrition, or malabsorption, due to the presence of intestinal infections. He believed that external factors such as hard physical work brought on an active pellagra when the latent state had developed. Ellinger examined the effects of a deficiency of different members of the vitamin B group on the excretion of abnormal porphyrin pigments, and just before the Second World War attempted to isolate and identify the light-sensitizing materials in buckwheat. Somewhat later (1942) he interested himself in the metabolism of nicotinamide in man and animals, and studied very thoroughly, during the next few years, the elimination of nicotinamide methochloride in normal and nicotinamide-deficient persons. The results of these researches revealed that the intestinal bacterial flora can form a very significant extra-dietary source of nicotinamide. His last investigations, on the heredity of the nicotinamide methylating mechanism in the rat and the elaboration of a new spectrophotometric method for tracing unknown urinary metabolites, remained unfinished.

Ellinger was highly cultured and widely travelled, and had many of the qualities of the typical German

Gelehrter, particularly the encyclopædic knowledge derived from much reading. He had a special love for pictures and a keen appreciation of the fine arts.

He was never a robust man, and during the closing years of his life, when his health deteriorated rapidly, his colleagues were deeply impressed by his fortitude, his complete occupation with the problems in hand and his absolute disregard of his own general frailty. Ellinger is survived by his wife, two sons and a daughter.

W. T. J. MORGAN

WE regret to announce the following deaths:

Prof. Jules Haag, director of the Institute of Chronometry at Besançon and non-resident member of the Paris Academy of Sciences, on February 16, aged seventy.

Dr. T. A. Jaggar, since 1940 research associate in the Hawaii National Park and an authority on volcanology, aged eighty-one.

Prof. Sergius Winogradsky, For.Mem.R.S., the distinguished bacteriologist, on February 24, aged ninety-six.

NEWS and VIEWS

Physical Chemistry in the Chester Beatty Research Institute, London: Dr. J. A. V. Butler

DR. J. A. V. BUTLER, who has just been appointed to the recently established chair of physical chemistry in the University of London tenable at the Chester Beatty Research Institute (Institute of Cancer Research, Royal Cancer Hospital), graduated in 1921 in the University of Birmingham, of which he became D.Sc. in 1927. During 1922–27 he was assistant lecturer in chemistry at the University College of Swansea, and in 1928 was awarded the Meldola Medal of the Institute of Chemistry. Then for the next twelve years he was lecturer in chemistry in the University of Edinburgh, and later spent two years as Rockefeller Research Fellow at the Rockefeller Institute, Princeton, N.J. He played an important part in the early days of the British Commonwealth Scientific Office in Washington, of which he was executive officer during 1942–44. In 1945 he became Courtauld Research Fellow at the Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London. Dr. Butler joined the Chester Beatty Research Institute in 1949, from which time he has devoted himself, with his school, to the application of the methods of biophysical chemistry to the problems of growth, the mode of action of ionizing radiations, and the mechanism of interaction of carcinogenic agents with nucleic acid and nucleoprotein.

Prof. Butler has contributed a notable series of papers and other publications to the scientific literature. A specially distinguished essay was his "General Thermodynamical System of Gibbs" (in "A Commentary on the Scientific Writings of J. Willard Gibbs", ed. F. G. Donnan and A. Haas, Yale 1936). A successful general work is his "Man is a Microcosm" (1950), and Prof. Butler has more recently acted as editor of "Electrical Phenomena at Interfaces" (1951), and (with Prof. J. T. Randall) of the important series "Progress in Biophysics and Biophysical Chemistry". His interest in the application of physical chemistry to biological problems is a new and significant development which the establishment of this new chair is intended to encourage and extend.

William Froude Memorial Fund

FOLLOWING a suggestion made at the Sixth International Conference of Tank Superintendents, held in Washington, D.C., during 1951, the Council of the Institution of Naval Architects has been considering a proposal to commemorate the pioneer work of William Froude, F.R.S. (1810–79), a pioneer in ship model research and naval architecture generally. His main work was carried out for the Admiralty, and in 1872 he undertook the building of an experimental tank for ship research at a site near Torquay, Devon, this being the first tank of its kind in the world. It has been decided that the memorial should consist of two parts: the erection of a bronze plaque at a suitable point (in a country lane) nearest to the site of the experimental tank; and the publication of a volume containing all Froude's published technical papers. The total sum for this is estimated at £2,500, and subscriptions to the memorial fund are invited. It is understood that about half the proposed sum has already been promised. Subscriptions should be sent to the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1, from whom all further information can be obtained.

Finances of Research Associations

A DEBATE was held on March 3 in the House of Commons on the Draft Cotton Industry Development Council (Amendment No. 2) Order, 1953, the chief purpose of which is to increase from £300,000 a year to £450,000 the maximum amount of the levy which the Cotton Board can, with the approval of the Board of Trade, impose, and during the course of the debate numerous tributes were paid to the work and achievements of the Cotton Industry Research Association. The Order will make it possible for the Cotton Board to increase by the amount of the additional levy its contribution to the British Cotton Industry Research Association (Shirley Institute) for the promotion of research, and the Order received warm support from all sides of the House. Nevertheless, and in spite of general recognition that the work of this and of other research associations is already seriously embarrassed by rising costs, the debate was marked by general concern for more information regarding the actual expenditure on research of the research associations and the Department of Scientific and Industrial Research. Some of the questions in the minds of members, such as the possibility of effective development, of overlapping in technical research and of proper liaison between different research associations concerned with natural and synthetic fibres, could not be raised under the terms of the debate. It was clear that members wished to be satisfied that the considerable sums of money concerned are, in fact, being wisely expended and without waste. The debate, in fact, testified to the value of more independent scrutinies of the work of the research associations such as has already been conducted for the British Leather Manufacturers' Research Association.

Russian Institute of Scientific Information

A new Institute, to be known as the Russian Institute of Scientific Information, has been established in the U.S.S.R. for the systematic supply of information from home and foreign sources relating to scientific and technical progress (*Vestnik Akad. Nauk*, 10, 92; 1952). Its main purposes, as specified by the U.S.S.R. Academy of Sciences, are: beginning with 1953 to publish an abstracting journal thoroughly covering world literature in mathematics, physical and chemical sciences, and from 1954 to extend its work to deal with biology, geology, geography and technology (engineering); to compile and publish reference books and bibliographies; to compile subject (thematic) reviews on developments in individual branches of science and technology in the U.S.S.R. and abroad; and to undertake translations and duplicating (photostating, etc.) work of journal articles as required by national institutions and industrial concerns. Three main divisions have been constituted as follows: scientific information work and editing of abstracts (referata); industrial publication; and administrative, etc. The Director of the new Institute, who is appointed by the Academy Presidium, is D. Yu. Panova.

Twenty-fifth Anniversary of the Discovery of the Raman Effect

A meeting of the members of the Indian Association for the Cultivation of Science was held on March 7 in the premises of the Association at Jadavpur to celebrate the twenty-fifth anniversary of the discovery of the Raman effect; Prof. M. N. Saha was in the chair. The sequence of events leading to the discovery of the Raman effect on February 28, 1928, was first narrated briefly by Prof. S. C. Sirkar, with the help of slides and demonstrations. Prof. Saha then pointed out that the discovery was one of the most important in science of this century and that not only the Association but also the whole of India took pride in the fact that such a discovery was made in the laboratories of the Association. A resolution congratulating Prof. C. V. Raman on the anniversary was passed and forwarded to him.

The United Nations Organization

Two recent publications by the United Nations Organization have been designed to direct popular attention to the activities of the Organization. The first, "Looking at the United Nations", gives a pictorial cross-section of the United Nations up to the end of 1951. Although only a brief sampling of the 34,000 pictures in the photo library of the United Nations Department of Public Information, they cover most of the important activities of the Organization during the past six years. The second, "United Nations in Pictures", has been compiled from picture features which have appeared in recent issues of the *United Nations Bulletin*. The picture stories in the booklet are grouped under general subject-headings including peace, security, economic progress, social advancement, the work for subject peoples and the development of international law. Copies of both booklets may be obtained from H.M. Stationery Office, London.

The Gannet in New Zealand

Apparent changes in the gannet population of New Zealand led to a desire that a census be taken to ascertain past population trends and to provide a basis for discussion of future changes. In 1946–47 the Ornithological Society of New Zealand adopted the gannet census as a project for co-operative study during the 1946–47 breeding season, and C. A. Fleming and K. A. Wodzicki were appointed organizers of the survey. They have now prepared a paper giving details of the census project and a summary of available data on the past history of the gannetries (*Notornis*, 5, No. 2; October 1952). The paper shows that there has been a general increase in the New Zealand gannet population during the past century. The reason for the suggested increase in total population cannot be stated. The Maoris used young gannets as food; but this was probably on a small scale. During the nineteenth century, Maori use of gannets became negligible. The gannet was protected in the Animal Protection Amendment Act, 1910. The effect of legal protection cannot have been great for there was no habitual use of gannets as bait by fishermen, or as food, before the Act was passed. There is no record of destruction on a large scale. The use of gannet guano on a commercial scale was once contemplated; but it has never been taken regularly in large quantities. A little guano is still removed from some gannetries; but there is no evidence that this affects the success of breeding. The change in man's influence on gannets is not enough to account for their increase in New Zealand. The apparent trend is perhaps due to fundamental changes in the ecology of the sea, possibly of a cyclic nature.

Seasoning Behaviour of Indian Timbers

In *Indian Forest Bulletin*, No. 154 (new series), M. A. Rehman, of the Wood Seasoning Branch of the Forest Research Institute, Dehra Dun, discusses "The Seasoning Behaviour of Indian Timbers" (Part 1; pp. 5+1 plate; Delhi: Manager of Publications, 1952; 8 annas or 9*d*.). In the days before the Research Institute came into being at Dehra Dun, seasoning of timber was practically unknown. Green timber from the forests, by the time it reached the market, may have become air-seasoned to a small extent, but usually not sufficiently to withstand the trying conditions of the climate in the variety of species now used in wood-work. A considerable amount of data on the air- and kiln-seasoning properties of Indian woods has been collected by the Wood Seasoning Branch during the past thirty-five years in the experiments carried on at Dehra Dun, as well as in the field in other parts of the country. Systematic accounts of the results of most of the air-drying tests have been published from time to time, but little information has so far been published by the Institute on kiln-drying studies. The object of this publication and subsequent parts is to assemble all the available information on air- and kiln-drying timbers of important Indian timber trees. The importance of adopting proper methods of seasoning wood before use is emphasized. The advantages of seasoning are discussed. The air and kiln seasoning of fir is described, and the kiln-drying schedule recommended for 1-in. planks of fir and for several other light hardwoods suitable for packing-cases is given.

Fossil Mammals of Africa

Two further papers based upon material collected by the British–Kenya Miocene Expedition have appeared in the series "Fossil Mammals of Africa", published by the British Museum (Natural History).

The first, No. 4, is on "Miocene Anthracotheriidæ from East Africa", by D. G. MacInnes (pp. 24+4 plates, 1951). The author comments on the fact that most of the East African fossil material is fragmentary, possibly as the result of scavenging animals attacking the dead bodies. The presence of a well-preserved skull and also some fragments of others enables the author to establish satisfactorily, and in some detail, a new species *Brachyodus æquatorialis*. The material included some limb bones and metapodials which, while not directly associated with the skulls, can reasonably be attributed to the same, or a closely allied species. Further information on *Hyoboops africanus* is also provided.

The second, No. 5, by W. E. Le Gros Clark and D. P. Thomas, is based on specimens of "The Miocene Lemuroids of East Africa" (pp. 20+3 plates, 1952). The material includes mandibular and maxillary fragments, a brain case and an endocranial cast. It all belongs to the sub-family Galaginæ and to the genus *Progalago*. The name was given because, when the type species *P. doræ* was described by D. G. MacInnes, it was considered that it represented a group from which the modern *Galago* might well have been derived. The paper adds considerably to our knowledge of the type species and also describes two further species of the genus, and the authors comment that none of the new evidence is contrary to the suggestion made with regard to the relationship of the genus with *Galago*. The plates accompanying both papers are of a high quality and very well reproduced.

Radioactive Starch and Hexose Sugars

THE preparation of radioactive starch, glucose and fructose from tobacco leaves after assimilation of $^{14}CO_2$ has been described by H. K. Porter and R. V. Martin (*J. Exp. Bot.*, **3**, 9, 326; 1952). In the photosynthesizing process, the experimental control of which is described, at least 80 per cent of the $^{14}CO_2$ supplied appeared in the leaves as starch and sugar and more than 80 per cent of the radioactivity was accounted for in these carbohydrates. Small amounts of radioactive carbon were also found to be incorporated in the protein, cellulose, hemicellulose and polyuronide components of the leaf.

3-Indolylacetonitrile: an Important Plant Hormone

INVESTIGATIONS of the recently discovered and important plant growth hormone, 3-indolylacetonitrile, and of 3-indolylacetaldehyde (reported to be present in plants), and both now available as pure synthetic substances, are described by J. A. Bentley, S. Housley and A. S. Bickel (*J. Exp. Bot.*, **3**, 9, 393, 406; 1952). As measured by their effects on cell-elongation in the coleoptile of *Avena*, 3-indolylacetaldehyde is considerably less active than 3-indolylacetic acid. An acidic substance is produced by the aldehyde during the period of assay, and in some experiments the aldehyde's activity could be accounted for on the assumption that it is transformed into 3-indolylacetic acid. Other evidence indicates that the aldehyde itself is either inactive or inhibitory. The nitrile, which is considerably more active than 3-indolylacetic acid, shows little production of acid during the period of assay. As the nitrile is destroyed by treatment with alkali but not with acid, the authors consider that earlier work on the identification of auxins in plants by their acid and alkali sensitivity should be re-examined. By using the *Avena* straight-growth test, in which the nitrile shows activity, evidence has now been obtained that it is present in various members of the Cruciferæ. Transport of the nitrile, like that of the acid, is polar, but it is considered that the nitrile can reach the growing cells as easily, if not more so, than the acid —a finding that is important in attempts to postulate the mechanism of nitrile action. The nitrile is less active in the *Avena* curvature test than the acid, and is inactive in the pea curvature and straight-growth tests except at high concentrations. It is inactive or only slightly active in the inhibition of lateral buds, in the inception of roots, and in petiole abscission at the concentrations tested. It is also less active than the acid in root inhibition in cress, but about as active in *Avena*. It is of about the same activity as the acid in the development of parthenocarpic fruit and the stimulation of cambial activity.

Total Eclipse of the Sun on June 30, 1954

A SUPPLEMENT to the "American Ephemeris and Nautical Almanac" for 1954 has been issued by the U.S. Naval Observatory, entitled "Total Eclipse of Sun, June 30, 1954" (pp. 42. Washington, D.C.: Govt. Printing Office, 1952; 40 cents). It is designed primarily for use along the path of the total phase of this eclipse, which will be visible in the United States, Canada and Greenland; but data are also given for the Atlantic Ocean and Europe. The maps provide local circumstances of the eclipse for all places within the limits of the eclipse region extending from the southern limit of the eclipse to lat 73° N., and from long. 170° W. to 80° E. Two tables give the necessary data for finding the position of the central line at various heights above sea-level and in the ionosphere up to 300 km., and also the duration of totality on the central line and the width of the path, at the earth's surface and at heights ranging from 100 to 300 km. The "American Ephemeris and Nautical Almanac" for 1954 gives a map for the complete eclipse area and also the Besselian elements and other usual eclipse data not given in the supplement, including an example of the calculation of the circumstances of the eclipse for a given place.

Catalogue of Horrebow Star-Pairs for the determination of Northern Latitudes

A CATALOGUE of star-pairs for northern latitudes from 55° to 70° for astronomic determination of latitudes by the Horrebow–Talcott method has been compiled by Pentti Kalaja (Suomen Geodeettisen Laitoksen Julkaisuja, No. 41. Pp. 191. Helsinki: Finnische Geodätischen Institute, 1952). The stars of Horrebow-pairs appearing in this catalogue have been selected from the "General Catalogue of 33,342 Stars for the Epoch 1950", by Benjamin Boss, and in the selection of the stars certain principles have been observed, among which the following may be noticed. The right ascensions of the stars must lie between 17h. and 24h. and their declinations between 30° and 85°. Stars of magnitudes between 3 and 7 only are admitted; experience has shown that it is not advantageous to use very bright stars, although their declinations are generally determined with great accuracy. The parallax of the star used must be less than 0·05″ and the probable error of the declination must be smaller than ± 0·40″. In addition, double stars, of which the distance from each other lies between 0·1″ and 6″ and the difference in magnitude is less than 3 m., have been rejected. Double stars which have circular or elliptical motion, and those which have peculiarities in proper motion, have also

been excluded. As the catalogue is intended for latitudes 55°–70° N., which includes nearly all of Finland, Sweden and Iceland, most of Norway, Denmark, Scotland and Alaska, the greater portion of Canada, and most of the Soviet Union, except the northernmost parts, the mean declinations of the stars must lie between 55° and 70°. Other conditions are that differences of magnitude of the stars must not exceed 2 and differences of right ascension for the stars of 1950·0 must lie between 2m. and 15m. More than 176 pages of tabular matter are included in the catalogue.

Earthquake Waves reflected at the Earth's Core

Probably the first mention of a transverse wave reflected at the boundary of the earth's core is to be found in a paper by F. J. Scrase in 1931 ("The Reflected Waves from Deep Focus Earthquakes", *Proc. Roy. Soc.*, A, 132; 1931). These pulses were observed by K. Wadate for an earthquake on November 13, 1932, and H. P. Berlage observed the waves at Amboina, his results being published in 1937 and 1939. S. W. Visser also noted the waves on the Amboina records of an earthquake on June 29, 1934, his book being published in 1937. R. A. Garrick (*New Zealand J. Sci. Tech.*, B, 31, No. 2; September 1949) has noted these pulses on New Zealand seismograms at epicentral distances of 0·92°, 2·25° and 3·45° for the earthquake of January 15, 1948, and has tabulated the readings. These results extend the observations by E. Tillotson (1939) and form a very valuable check on the "Seismological Tables".

Iron and Steel Institute: Awards

The following awards have been made by the Iron and Steel Institute: *Bessemer Medal for* 1953, to R. Mather, of Skinningrove Iron Co., Ltd., and past-president of the Institute, for his distinguished services to the Institute and to industry; *Sir Robert Hadfield Medal for* 1953, to W. E. Bardgett, research manager of the Central Research Laboratories of the United Steel Companies, Ltd., in recognition of his contribution to the development of alloy steels, with particular reference to steels for service at elevated temperatures; an *Andrew Carnegie Silver Medal for* 1952, to Dr. E. T. Turkdogan, now with the British Iron and Steel Research Association, for his research on slag-metal reactions reported in various papers, his results being written in collaboration with Dr. W. R. Maddocks (*J. Iron and Steel Inst.*, July 1949, and June and September 1952); *Ablett Prize for* 1952, jointly (£50 each) to Dr. S. A. Burke and G. A. Sparham, of the British Coal Utilization Research Association, for their paper on the automatic control of coal feed in steelworks gas-producers (*J. Iron and Steel Inst.*, November 1952). No award was made of the Williams Prize.

Grants of the U.S. National Science Foundation Awards

The National Science Foundation has recently made seventy-eight grants, totalling 685,200 dollars, to institutions in the United States for research in the biological and the physical sciences and for the support of studies and conferences on science and scientific education. This is the second group of awards to be announced under the Foundation's programme for the support of basic research, bringing the total number of research grants made this year to one hundred and thirty, worth 1,340,650 dollars. The fields included are astronomy, chemistry, developmental biology, earth sciences, engineering, environmental biology, genetic biology, mathematics, microbiology, molecular biology, physics, psychobiology, regulatory biology, research education in the sciences, scientific information, studies in science and systematic biology. The duration of research grants in this latest group of awards ranges from eight months to three years, with an average length of 1·6 years; the average grant amounts to 5,475 dollars a year.

University of London: Appointments

The following appointments have been made in the University of London: Mr. J. Durbin, lecturer in statistics at the London School of Economics and Political Science, to the university readership in statistics tenable at the School; Dr. D. A. McDonald, senior lecturer in physiology at St. Bartholomew's Hospital Medical College, to the university readership in physiology tenable at the College; Mr. A. E. Smailes, reader in geography at University College, London, to the university readership in geography tenable at Queen Mary College.

Announcements

Dr. Keith Murray, rector of Lincoln College, Oxford, has been appointed chairman of the University Grants Committee in succession to Sir Arthur Trueman, who is retiring on October 1 for reasons of health.

The second international conference on the biology and cultivation of the mushroom will be held at Gembloux, Belgium, during June 16–24. Further information can be obtained from the honorary secretary, Mlle. L. Engels, C.E.R.E.C., Institut Agronomique de l'État, Gembloux.

The spring conference of the Institute of Metal Finishing will be held in the Hotel Majestic, Harrogate, during April 22–25. The conference will begin with an informal reception and dinner on April 22, and during the next three days there will be four technical sessions on, respectively, organic and other non-electrodeposited coatings, electrodeposition, fundamental electrode processes and shop practice. Further information can be obtained from the Conference Secretary, 32 Great Ormond Street, London, W.C.1.

The Textile Institute is offering a Cotton Industry War Memorial Trust Scholarship, of maximum value £950, for a three-year course in textile technology at an advanced level, with provision for industrial training and experience of a special character in Britain or overseas. The closing date for applications is April 30. The Institute is also offering a new scholarship, to be known as the 'Peter Coats' Scholarship, since it has been established by the will of the late Mr. Coats, of Paisley, and this award, which is of maximum value £200, is intended to enable a person who has already been awarded or promised a scholarship in advanced textile technology to pursue a year of full-time study preparatory to taking up his main course at a university or college. The closing date for applications is May 30. Candidates for both these awards must be male British nationals less than twenty-four years of age. Application forms and further information can be obtained from the General Secretary, Textile Institute, 10 Blackfriars Street, Manchester 3.

RECENT ADVANCES IN MICROBIOLOGICAL METHODS

VARIOUS aspects of recent advances in microbiological methods were discussed at a joint meeting of the Society for Applied Bacteriology and the Microbiological Group of the Society of Chemistry and Industry, which was held at the Institution of Civil Engineers, Great George Street, London, on January 14. Dr. J. G. Davis presided at the meeting.

Prof. M. Stacey opened the meeting with a paper on the "Chemistry of Gram Staining and of the Feulgen and Dische Reactions for Nuclear Material". Mention was made of the need to put the important microbiological and histological staining techniques on to a firm chemical basis. Profound chemical differences exist between the two groups of organisms: the Gram-positives, which can be stained by Gram's basic fuchsin – iodine technique; and the Gram-negatives, which do not retain the stain on being washed with alcohol. By means of bile salts Gram-positives can be stripped of their surface material, leaving a Gram-negative cytoskeleton. When this is kept under reducing conditions, it is found that magnesium ribonucleate from the bile salt extract or from other sources will combine with it in such a way that the Gram-positive state can be restored. It is considered that the dye-retaining complex is a magnesium ribonucleoprotein located near the cell surface of Gram-positives. Gram-negatives, on the other hand, although possessing ribonucleic acids, have surface material composed of phospholipids, protein and polysaccharides.

The significance of ribonucleic acid in the Gram-complex can be emphasized by the use of ribonucleases and autolytic enzymes from the cell. Cells rendered Gram-negative by the action of lytic enzymes are difficult to reconstitute unless they are first treated with the protein component of the Gram-complex, followed by addition of the magnesium ribonucleate. Mechanical disruption of cell surfaces completely destroys the possibility of reconstituting the Gram-complex.

Deoxyribonucleic acid plays no part in the Gram-complex; but its deoxy sugar component is implicated in both the Dische diphenylamine and Feulgen reactions for nuclear material. The Dische reaction is explained by the finding that 2-deoxypentoses under the strongly acidic conditions of the test are transformed into ω-hydroxy lævulic aldehyde that combines with diphenylamine to give a blue dye which, in the Spekker, has a characteristic band with a single peak.

The Feulgen test can be explained as a result of extensive investigations on the properties of 2-deoxy sugars. Under mildly acidic conditions the 2-deoxyribofuranose component of the nuclear material readily loses some of the groups attached at the reducing carbon atom, and the sugar ring opens to give an aldehydo-sugar. This gives an intense insoluble dye with the Schiff's reagent used in the Feulgen test. Further implications of the known behaviour of deoxy sugars were mentioned. In the discussion which followed, Prof. Stacey was unable to explain some of the observations of various investigators during Gram-staining, and he mentioned that magnesium is not completely specific in the Gram-replating technique.

The next speaker was Dr. E. Windle Taylor, who described the "Use of the Membrane Filter in the Bacteriological Examination of Water". He said that collodion membranes not only retain all micro-organisms from a large volume of liquid, but can also be placed in contact with a substrate which conveys nutrients through the pores to the deposited bacteria so that they can be cultivated *in situ*. The substrate takes the form of an absorbent pad which can be soaked with concentrated nutrient. The use of the apparatus is quite simple, but sterilization of the membranes requires great care. After much trial it has been found possible, without harming the membranes, to autoclave them for ten minutes at 10 lb./sq. in. pressure if they are stacked alternately with absorbent pads and the pile wrapped in kraft paper.

The main lines of investigation were to ascertain whether the apparatus and technique could be applied to media and methods commonly employed in Britain for the bacteriological examination of water, and this has been established in a satisfactory manner. The amount of liquid that can be filtered in a given time through each membrane depends upon the amount of suspended matter, and varies from two litres in ten minutes for tap water to a quarter of a litre in one hour for sewage effluent. Double-strength nutrient broth is used for colony counts, and figures obtained closely follow the corresponding agar counts, while in certain circumstances, such as pure chalk waters, larger volumes can be examined. Colonies first become visible after eight hours incubation and reach a maximum after eighteen hours. MacConkey broth can be used for the coliform examination, if made up in triple strength but with bromcresol-purple indicator of twelve times strength. The lactose-fermenting colonies are clearly distinguishable as pale yellow colonies on a blue background. Colonies are first seen after eight hours incubation, and a maximum number is reached after twelve hours incubation. Preliminary resuscitation of bacteria with nutrient broth and the achievement of direct *Bact. coli* counts are matters for further study.

Pathogenic bacteria have been successfully isolated by membrane filtration by cultivating the membrane in selenite broth, thus saving a large volume of medium; no success has yet been achieved in producing typical colonies of enteric organisms on a membrane and pad impregnated with a liquid form of Wilson–Blair medium.

The chief advantages of the technique are concentration of organisms, removal of inhibitory substances in the water itself, saving of glassware and media and, in the case of the coliform test, the avoidance of false presumptive results due to spore-forming anaerobic lactose-fermenters. There appears to be a field of exploration along three main lines to assess the applicability of filter membranes in the bacteriological examination of water: for examining a series of samples, as in a river or a lake survey; where a rapid result is required; and for isolating pathogenic organisms from sewage effluents and polluted waters.

In the lively discussion which followed, various speakers mentioned their own experiences with the membrane filters and the commercial availability

of various types, and the general feeling was reached that the filters would prove very valuable.

In the next paper, Dr. L. A. Allen described the "Enumeration of *Bacterium coli* and of *Streptococcus fæcalis*". Growth of *Bact. coli* on bile salts – lactose agar at 44° C. has been found to be conditioned by a number of factors. The temperature of 44° C. is critical for this organism, and an accurately controlled water-bath is essential. The inclusion of phosphate in the medium reduced the count of all strains tested, and some strains were virtually unable to grow under these conditions. When the bacteria are suspended in water, the proportion of the total population able to grow on the bile salts medium at 44° C. tends to decrease as the period of suspension is prolonged. This result of attenuation can be largely overcome by dividing the medium into two parts, each of double strength—lactose broth ; and a solution containing the bile salts, indicator and agar —and subjecting the inoculum to a short period of incubation in the lactose broth at 37° C. before adding the second part of the medium and incubating at 44° C. 'Resuscitation' for one hour in this way results in a count on bile salts – lactose agar at 44° C. which approximates to the count on Yeastrel – glucose agar at 37° C. The film of agar is formed in a rotating bottle which can afterwards be directly immersed in a water-bath. The temperature cannot be controlled with sufficient accuracy if Petri dishes are used.

Evidence has accumulated in recent years that *Str. fæcalis* may be a useful indicator of fæcal contamination when used in conjunction with conventional tests for coliform bacteria. As a result of a similar study of the growth of this organism on 'Yeastrel' – glucose azide agar, a technique has been formulated for obtaining a colony count on this medium at 45° C. *Str. fæcalis* was found to be so sensitive to neutral red that it was necessary to leave this indicator out of the medium altogether. Phosphate exerts no depressing action on the count, provided it is not included with the other constituents of the medium before autoclaving. As with *Bact. coli*, 'resuscitation' largely overcomes the inability of attenuated cells to form colonies on this medium.

The principle of resuscitation has been applied to the determination of the most probable number of both organisms for use with samples in which the numbers of bacteria are too small to permit of an accurate colony-count. The resuscitation method has been found to give significantly higher results than existing methods for both organisms, it requires less time for completion, and it is virtually specific for the organism concerned.

Following the comments on this paper, Dr. S. T. Cowan dealt with "Microchemical Methods for the Characterization of Bacteria". He said that the reproducibility of a biochemical test depends on the ability of the organism to produce appropriate enzymes and also on the medium, temperature and duration of incubation, volatilization or utilization of the end-product, and the sensitivity of the test reagents. Bacteria are essentially complex enzyme systems and are most easily studied by letting non-growing cell suspensions act on defined substrates. This principle can be applied to the biochemical tests used in bacteriological laboratories, one enzyme system being tested at a time. Each test depends on the action of a very heavy suspension of the organism : the heavier the suspension, the quicker the reaction ; and a minimum density equivalent to 10^9 *Bacterium coli*/ml. is essential.

Fermentations are carried out by mixing sugar solution, bromthymol blue and bacterial suspension and incubating at 37° C. The method is sensitive and shows acid production by organisms which, in growing cultures, appear to lack fermentative ability. Other tests for glucose breakdown can be adapted to the micro-methods using suspensions. A micro-method for the methyl red test (ability to produce a *p*H of 5 or less from glucose) is being developed. Acetoin (acetylmethylcarbinol) can be detected readily ; but, as the enzyme is adaptive, the suspension should be made from growth on a glucose medium. Hydrogen sulphide production can only be observed when there is an adequate source of sulphur available ; cysteine hydrochloride is suitable for all the bacteria examined, but the test using cysteine and lead acetate paper is so sensitive that it has little differential value.

Nitrate reduction, the production of indole, and urease are other tests that can be carried out quickly with suspensions and the appropriate substrates. All the micro-methods so far developed are simple to set up and are quick in action ; the specificity of the tests depends on the test reagents.

By testing each enzyme system separately, it should be possible to characterize a bacterium by its enzymic formula, much as a serologist characterizes it by an antigenic formula. The micro-methods should be readily adaptable to studies on the availability of different amino-acids.

Numerous speakers commented on the paper, and the useful suggestion was made by Mr. H. B. Hawley that the chromatographic purity of the sugars used by Dr. Cowan should be checked.

Finally, Mr. J. Tramer spoke on "Use of Bacterial Phosphatases in Differentiating Certain Micro-Organisms". Bray and King investigated, in 1943, the production of phosphatase by growing organisms as a possible aid for their differentiation. They assessed the phosphatase activity of a wide variety of species by incorporating phenolphthalein phosphate in an egg medium. The amount of phenolphthalein liberated from the substrate by phosphatase served as an indication of the amount of enzyme produced. They found their relative simple technique of value in differentiating between members of certain genera, but thought the slow rate of hydrolysis of their substrate to be a disadvantage.

Barber and Kuper examined, in 1951, the possibility of distinguishing between pathogenic and non-pathogenic staphylococci by their respective phosphatase reactions. They used phenolphthalein diphosphoric acid which, when suitably incorporated into an agar medium, allowed good differentiation between phosphatase-negative colonies, which were found to be coagulase-negative and therefore non-pathogenic, and phosphatase-positive colonies which proved to be coagulase-positive and only rarely coagulase-negative.

Yet another substrate, disodium *p*-nitrophenyl-phosphate, has been shown to be useful in the estimation of phosphatase activity. It is colourless in solution but produces, on hydrolysis by phosphatase, free *p*-nitrophenol, which is yellow in neutral and alkaline solution and serves as a measure of enzyme activity. Although not heat-stable, solutions can be Seitz-filtered and incorporated into solid and liquid media. On solid media, colonies of phosphatase-producing organisms will show a yellow colour after a suitable incubation time, and liquid media will turn yellow if such organisms are present. Plates

containing media into which disodium *p*-nitrophenylphosphate has been incorporated can be used for streaking, and it has been found practicable to flood inoculated and incubated normal milk agar plates with a small amount of a disodium *p*-nitrophenylphosphate solution. In the latter case, surface colonies of strong phosphatase-producing organisms will turn yellow in a few minutes.

The estimation can be made quantitative by incubating a measured amount of bacterial suspension with a suitably buffered or unbuffered solution of disodium *p*-nitrophenylphosphate for a certain time (half an hour to several hours) and estimating the colour developed in a comparator using permanent colour standards, or photo-electrically. Using such a procedure, a good relationship was found between phosphatase activity and gelatine liquefaction time of Voges–Proskauer positive, methyl red negative Coli-aerogenes organism. *Bact. cloacæ* appears to be in general a non-, or only weak, phosphatase-producer, while *Bact. aerogenes* and also the 44° C. positive type (Irregular VI) are strong phosphatase-producers.

In addition to the degree of phosphatase activity and its correlation to another biochemical reaction, there are certain characteristics of the bacterial phosphatase produced which may be of value in differentiating micro-organisms. Pett and Wynne have shown that the *p*H optimum may be of value in this respect, and it is suggested that the heat stability in certain media and the activity of a cell-free filtrate may also be of use.

CHEMISTRY AND INTER-RELATIONSHIPS OF ENDOCRINE SYSTEMS AND THEIR PSYCHOLOGICAL EFFECTS

AN evening discussion meeting on this theme was held on February 26 by the Society for Visiting Scientists at 5 Old Burlington Street, London, W.1, Dr. A. S. Parkes (National Institute for Medical Research, Mill Hill) being in the chair.

Prof. Jean Roche (Collège de France, Paris) spoke first, his subject being the biochemical aspects of hormone actions. One of the major concepts influencing biochemical thought and research in the present century is that of bio-catalysts—substances of great importance profoundly influencing the rate of chemical reactions in the body, and effective in small or minute amounts. Within this general group are substances which were at first thought of as being of a very different nature—vitamins, hormones and enzymes. The demonstration that many, perhaps all, vitamins act by virtue of their intimate association with the enzymes concerned with fundamental metabolic processes in the body is of immense significance.

In the case of the hormones, early work was concerned mainly with their physiological, rather than with their biochemical, actions; the biochemist could approach their study only indirectly by studying their effects on tissue enzymes, and after this action had been shown to be specific, both for the hormone and the enzyme involved. For example, the administration of œstrogens to the castrate female animal produces a marked rise in the alkaline phosphatase content of the uterus, but not of other tissues. Progesterone alone has almost no effect but, given with œstrogens, prevents this rise in enzyme content. Arginase is an enzyme of great importance in the mammals, because of its part in the Krebs cycle for the conversion of ammonia to urea—the main nitrogenous excretion product in this group. More recently, androgens have been shown to increase the concentration of this enzyme in the kidney; the concentration in other organs and of other enzymes in the kidney is not affected. The response is not produced by other sterol hormones without androgenic activity. Similarly, Folley and Greenbaum have demonstrated a marked (hundred-fold) increase in the concentration of this enzyme in the mammary gland following parturition as lactation begins under hormonal influence. These and other observations suggest that tissues can respond by specific enzyme changes in response to specific hormones, and that through such studies the biochemist can make valuable contributions to the least well-known aspect of endocrine function—the mechanism of their peripheral action.

Prof. F. G. Young (Cambridge) suggested that hormones might be defined as substances liberated into the blood stream to produce changes in tissues at a distance. As Prof. Roche had already emphasized, their action is most probably exerted by their effect on the chemical processes of the receptor cells. As a parallel to their marked actions in chemically small amounts, the early workers in this field had difficulty in gaining general acceptance for their concepts as there was reluctance to admit that such physically insignificant organs as the pituitary and adrenal glands and the apparently unimportant islet cells of the pancreas could be of supreme importance to the maintenance of life. Full acceptance was delayed until it was shown that the disastrous results of experimental removal of these 'inner secreting' or endocrine glands could be reversed by injections of potent extracts from them. Even the central nervous system, which at the time when the early observations were made, such as that of Addison in 1855, was thought to be the dominant controlling system, has been shown to depend largely on the maintenance of the correct balance of endocrine activity for its proper functioning. The level of sugar in the circulating blood is largely under hormonal control: a doubling leads to diabetes and severe metabolic upset; a halving to coma, convulsions and death.

Chemically, the hormones are a very heterogeneous group; even in a single gland there is often a multiple secretion rather than a single hormone. Very recently it has been shown that the thyroid, formerly thought to secrete only one effective chemical substance—the iodo-amino-acid thyroxine—probably secretes also the closely related and more active 3′-3-5-tri-iodothyronine.

In conclusion, Prof. Young pointed out that many endocrine glands are derived embryologically from 'barrier' tissues—the ectoderm separating the animal from the external environment, and the endoderm of the alimentary canal coming between the body as a whole and the gut lumen. He postulated that one important action of hormones in the tissues might be concerned with increasing or decreasing the rate at which important metabolites cross the barrier of the cell membranes.

Prof. G. W. Harris (Institute of Psychiatry, University of London) said that the profound effects

of the endocrines on the nervous system and behaviour, and more recently the influence of the nervous system on endocrine function, have been known in a general way to those engaged in medical practice for many years. The deliberate experimental study of the extent and mechanism of these inter-relationships is a more recent development. Of the influence of hormones on behaviour, still very little is known except in certain limited fields. The studies of Beach on the modification of animal behaviour under the influence of sex hormones are outstanding in this field. Nervous control of the endocrine glands has been more extensively studied and more is known of this.

Despite the fact that only two endocrine glands—the adrenal medulla and the posterior pituitary—are known to have an anatomically obvious and functionally important direct nerve supply, nervous factors are known to play an important part in endocrine function. Marshall's original investigations on the importance of "exteroceptive factors", such as light and temperature, on the sex rhythms of lower animals, have been confirmed and extended in great detail. More recently the responses of the adrenal cortex under the control of the adrenocorticotrophic hormone of the anterior pituitary have been exhaustively studied. An animal exposed to physical or chemical trauma, or to various procedures such as forced immobilization or loud noises, all presumed to cause mental disturbance and, for want of a more precise term, grouped together as 'emotional stresses', exhibits definite signs of increased adrenal cortical activity. Recent work in Prof. Harris's laboratory seems to indicate that in rabbits the activity of the thyroid gland, under the control of pituitary thyrotrophic hormone, decreases in response to such 'stresses' that are known to activate the suprarenal gland. The clinical impression that emotional disturbance may be a precipitating factor in the onset of human hyperthyroidism is another indication of nervous influence on thyroid function.

There is, therefore, a very considerable body of evidence, from many sources, of nervous and mental influence on endocrine function, mediated mainly via variations in the output of the trophic hormones of the anterior pituitary gland.

The discussion at the meeting centred mainly on the influence of psychological factors on endocrine function. Various speakers commented on the difference in response of the experimental animal and man with respect to thyroid function. Prof. Harris replied that the depression seen in his animals was unexpected in view of the information available about human disease. A species difference was postulated by other members of the audience. Different responses in the same species to similar physical stress accompanied by presumably different emotional states were described; in the ritual fighting of male mice kept together, the blood sugar of the aggressor is elevated, but not that of the attacked animal, though both exhibit violent physical activity.

Dr. Parkes, in his summing-up, re-emphasized the importance of the approach discussed by Profs. Roche and Young—the detailed study of the mechanism of peripheral action of the hormones. For the non-chemical endocrinologist, perhaps the most valuable and promising field for future research is the influence that the external environment, acting through the central nervous system, exerts upon the endocrine state of the organism.

ANALYSIS OF MECHANICAL AND ELECTRICAL ENGINEERING FAILURES

BEFORE the Second World War the British Engine Boiler and Electrical Insurance Co., Ltd., issued annually a technical report dealing both with original work and with the investigation of engineering failures. Vol. 1 of a new series has just been published, which more than maintains the high standard of its predecessors*. This publication will be found to be of the very greatest interest by all engineers and metallurgists who are concerned with the field common to the two professions.

The first forty-five pages are devoted to a most commendable discussion from the practical point of view of caustic cracking in steam boilers, possibly the most comprehensive treatment which has so far appeared. A very considerable number of cases are discussed in detail, and since neither chemists nor metallurgists are as yet in complete agreement as to the details of the fundamental mechanism involved, and since no reliable means of preventing this dangerous form of deterioration has been developed, these are the more valuable. It is suggested that the best advice that can be offered in the light of present knowledge is that the workmanship of new boilers should be of a high standard, particularly as regards the sealing of the riveted seams on the water side; that care should be taken to avoid over-heating, rapid fluctuations of temperature, and other factors arising under working conditions which may disturb the seams; that special care is required in repair work in connexion with the sealing of such seams; and the maintenance of a minimum caustic alkalinity of the boiler water and the maintenance of a sodium sulphate/sodium hydroxide ratio above 2·5.

A most interesting account by Mr. G. A. Cottell of original work on the sources of error in notched-bar testing concludes this publication. The apparatus is described and the sources of error carefully differentiated; in particular, the influence of the seat between the specimen and the machine has been investigated and a new form suggested which cuts down the loss very considerably and, at the same time, eliminates much of the scatter found under normal conditions. It is shown that the results of such losses may reach as high a value as 25 per cent. It is of more than a little interest that, when using a modified form of specimen or a modified type of test, the yield point is clearly shown, even under notched-bar conditions. A fact of great interest which emerges from this work is the evidence that the speed of fracture exerts a considerable influence on the results. A comparison is made between impact and slow-bend tests on identical specimens, and it is shown that the total work of fracture with the Izod specimen is almost 20 per cent higher in impact than when the specimen is broken slowly. A continuation of this work will be looked for by many.

The remainder of the report is concerned with the examination of twenty-seven cases of service failure, a typical one being that of the brittle fracture of a crane hook, which is referred to strain age-embrittlement in a rimming steel, resulting from the strain and heating due to compression and abrasion. A similar example of strain age-embrittlement in a

* British Engine Boiler and Electrical Insurance Co., Ltd. Technical Report, New Series, Vol. 1. Pp. 212. (From the Company, 24 Fennel Street, Manchester 4, 1952.) 12s. 6d.

rimming steel occurred in the case of some boiler rivets, the brittleness being traced to the presence of nitride 'needles'. Such work is in a direct line with the tradition in these reports, since Stromeyer's work on the effect of nitrogen in embrittling steel was carried out in the laboratories of the Manchester Steam Users' Association, now taken over by the Company which has issued this report. Incidentally, the same tradition can be traced in the work on the notched-bar test, a subject on which Schuster carried out considerable research.

The account of these investigations on engineering parts which have failed is very welcome. Only too often, service failures are hidden in the scrap heap, and careful investigation can be of immense value in minimizing the danger of further fractures from the same cause. These investigations cover both the mechanical and electrical fields. In the latter there is also an article by D. C. Bacon on "Excess Current Protection of Electric Motor Circuits". Among the failures which are reported are those due to the cracking of a riveted seam due to excess riveting pressure, tube failures, butt-welded joints, failure of turbine blades and shaft, fracture of a steam engine crank-shaft, an accident to an electric goods-lift, defective squirrel-cage motor-rotors, the disruption of a hydro-extractor, and the explosion of an air vessel. In all, these reports provide a very considerable amount of information which should be of value both in design and in the maintenance of mechanical and electrical equipment.

The presentation of this work is more than good, the illustrations and micrographs are excellent, and at the low price at which it is issued should appeal to a very wide range of readers. F. C. THOMPSON

UNIVERSITY OF WITTENBERG (1502–1952)

THE Martin-Luther University of Halle-Wittenberg, in the East Zone of Germany, held a celebration during October 18–25, 1952, to mark the four hundred and fiftieth anniversary of its foundation at Wittenberg, nearly two hundred years before the separate foundation of the University at Halle, with which it was merged on reopening in 1815 after being closed in 1813 by Napoleon. The pro-rector, Prof. Leo Stern, acted for the rector, Prof. Rudolf Agricola, who was absent through illness. The following details are given in a letter from one of the West Zone delegates.

The opening ceremony was in the Theatre of Peace at Halle. A colourful scene was provided by the university professors, deans, pro-rectors and rectors in their robes. The celebration on Sunday, October 19, took place in the town church of Wittenberg; Prof. Aland gave the address, and at a church service in the afternoon the sermon was preached by Bishop Dibelius. The ceremony was attended by Hungarian and Roumanian bishops, by a representative of the Chinese Christian Reform Movement, and by the Rev. Edward Charles, from Great Britain. On October 20 there was a function, at which scientific addresses were given, at the Institute for German History, a student youth demonstration in the market, and musical performances (Handel, Bach, Brahms and others). On the following day a special meeting of the Leopoldina Academy was held, with lectures and demonstrations on the theme "Der schwerhörige Mensch". The birthplace of the Leopoldina Academy—Schweinfurt in the West Zone of Germany—was officially represented by its mayor, Dr. O. Schön, and by Dr. J. Helfrich, who had already represented his town at Halle for the tercentenary of the Leopoldina Academy in February 1952 (see *Nature*, 169, 576, and 170, 1105; 1952), and they were most warmly received. There followed numerous parallel sittings of the different faculties, with exhibitions. Receptions were held by members of the East Zone Government, by the regional and civic authorities and by the University Senate, and a performance was given of Handel's opera "Tamerlano". R. C. H. YOUNG

FORESTRY RESEARCH AND ORGANIZATION

TWO papers read at the Sixth British Commonwealth Forestry Conference, held in Canada last year, and now published by the Forestry Commission (London: H.M.S.O., 1952), deserve to be more widely noticed for the scientific importance of their message. The first was by Mr. J. N. R. Jeffers, of the Forestry Commission, London, who discussed the use of statistical methods in forest research. 'To-day," he said, "the handling of figures has become a necessity; they are required for administration, management and research, and their collection, analysis and interpretation have become part of the forester's everyday work." The functions of these methods are to provide a sound basis for the design of experiments, to summarize data so that they can be correctly and readily interpreted, and to give an estimate of the probability that the effects indicated by the results are true effects. Statistical methods have become indispensable tools of forest research. It is now a question of making more foresters familiar with them and of asking statisticians to develop new methods when the existing ones are inadequate.

It may be pointed out, in passing, that this is more applicable to the research officer, for the forester's everyday work is, or should be, out in the forests and woods studying the methods of growth and well-being of his trees and their several requirements from the practical sylvicultural point of view on the ground. His job is to produce the timber, etc., of the future by practical sylviculture and constant supervision on the ground. Statistics, though necessary, will not do this.

The other paper was by Mr. N. V. Brasnett, on the "Organization of Sustained Yield in previously Unmanaged Forests". He stated: "For periods within the physical rotations of the species which comprise them, mature, unmanaged forests can be assumed to be in a state of dynamic equilibrium. Large old trees are generally in excess of medium-sized and small trees of the same species, which only have an opportunity of entering the top canopy as overmature trees die. Because no increment is harvested, it has slowed down until it is practically balanced by decay. The smaller trees are not all necessarily younger than the large ones, but may merely be suppressed and even capable of responding to release. Abundant seedlings are liable to appear on the forest floor in most years, but most of them fade away in a few years, leaving only individuals to survive in gaps here and there". The British have

the greatest experience in dealing with large areas of tropical and sub-tropical, previously unmanaged forests. British foresters in India for nearly ninety years have been studying and wrestling with the problem of introducing an orderly management and a sustained yield in forests of these types, and a great deal of valuable sylvicultural knowledge has been gathered. The numerous working plans in force throughout India furnish evidence of the advanced position attained. Mr. Brasnett's paper deals with the various problems entailed in introducing a detailed management into the previously unmanaged forest.

A NEW METHOD OF MEASURING SPERM SPEEDS

By Lord ROTHSCHILD

Department of Zoology, University of Cambridge

In Chandrasekhar's review on "Stochastic Processes in Physics and Astronomy"[1], the following footnote occurs on p. 89: "Fürth made systematic counts of the number of pedestrians in a [street] block every five seconds. . . . It is amusing that by systematic counts of the kind made by Fürth it is possible actually to determine the average speed of a pedestrian!" The principle involved in such determinations is known as probability-after-effect, and it occurred to me that if the average walking speed of a pedestrian can be determined by this method, the same should apply in the case of spermatozoa, though the latter move in three or in certain circumstances two dimensions, whereas in Fürth's problem the pedestrians only moved in one dimension, that is to the right or the left.

Very little is known about the relationship between the speeds at which spermatozoa swim and their fertilizing capacity, or about the effects of changes in the physical and chemical properties of the medium on sperm movement. These gaps in our knowledge are mainly due to the difficulties which have been experienced in measuring the speeds at which spermatozoa swim. Hitherto such measurements have presented great problems, mainly because photographic methods are not readily applicable to dense sperm suspensions. If the suspensions are diluted sufficiently for photography, the spermatozoa may exhibit pathological changes unless protective substances, which interfere with the measurements, are added to the medium. The electrical method of measuring sperm activity cannot be applied to human spermatozoa because the number of sperm per millilitre of ejaculate is not sufficient to cause the 'wave formation' observed in bull and ram semen, upon which the method depends[2]. Recently, Bosselaar and Spronk[3] have reported a new way of measuring what they call the 'motility' and concentration of spermatozoa. Apart from the objections made to the method by the authors themselves, no estimates of sperm speeds are given in that article.

One can, of course, take a high-speed cinemicrograph of a dense suspension of spermatozoa and then project the film frame by frame on to squared paper, marking the consecutive positions taken up by individual spermatozoa and joining these points together by straight lines. The total length of these lines divided by the overall magnification and the duration of the film gives the speed of each spermatozoon. This process is much too slow and expensive for regular use, though it has been used for verifying the experiments described in this communication; moreover, the person joining up the consecutive positions of sperm heads may have to make difficult decisions as to where a spermatozoon on frame 1 has got to on frame 2. One experiment lasting 30 sec., which takes 2¼ hr. to analyse by the new method, takes about a week to analyse by examination of high-speed cinemicrographs.

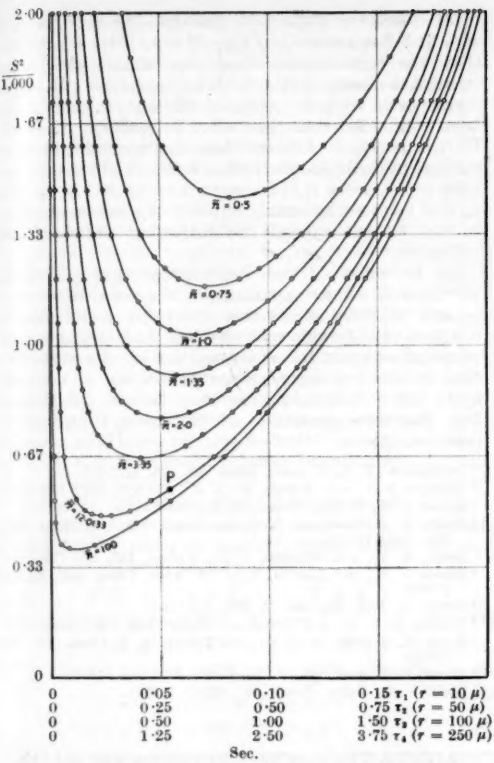
In the probability-after-effect method of measuring the average speed of spermatozoa, a small drop of semen, or semen diluted 1:2—1:5 with a suitable diluent, is placed on a microscope slide. A coverslip is gently put on top of the drop, which should be of such a size that, after the coverslip is placed on top, the spermatozoa only swim in one plane. This is not difficult to achieve as spermatozoa often tend to swim in one plane when constrained by a coverslip. A cinematograph film is then taken of the suspension, preferably with a phase-contrast microscope. An overall magnification of about 200 is convenient. The camera should run at 4–10 frames/sec. After developing and fixing, the film is projected on to paper on which a circle of known radius r has been drawn; the number of spermatozoa in this circle is then counted on consecutive frames. The circle should be of such a radius that it contains between 10 and 20 spermatozoa. After the counts have been made we have a series of numbers, as in the row labelled n in the accompanying table. The calculation of the average speed of the spermatozoa from these numbers requires no knowledge of mathematics beyond logarithms and the use of standard tables. The average value of these numbers, $\bar{n}$, and the average value of the squares of the differences between consecutive numbers, δ^2, are first calculated, as in the table. Suppose that in this experiment the camera speed was 3·7 frames a second, which means that the time interval, τ, between photographs was 0·27 sec.; and that the radius of the circle was 51 μ. The average speed, $\bar{c}$, of the sperm suspension is given by the equation:

$$\bar{c} = -3{\cdot}6169\, r/\tau \log_{10}(1 - \overline{\delta^2}/2\bar{n}). \qquad (1)$$

The minus sign in front of the right-hand side of this equation arises because $\log_{10}(1 - \overline{\delta^2}/2\bar{n})$ is negative. Substituting the values obtained above in this equation, we obtain $\bar{c} = 120\,\mu$/sec., the average speed of the spermatozoa in bull semen diluted 1/4 with Ringer fructose at 37° C.

No., n, of sperm in circle	9 10 15 11 12 12 9 10 14 15	Sum, 117
Difference, δ, between consecutive numbers	1 5 4 1 0 3 1 4 1	
δ^2	1 25 16 1 0 9 1 16 1	Sum, 70
Average value of n, $\bar{n} = 117/10 = 11{\cdot}7$ Average value of δ^2, $\overline{\delta^2} = 70/9 = 7{\cdot}7778$		

To obtain reasonable precision, more counts than ten, a number chosen for purposes of illustration of the method in the table, should be made. When the number of spermatozoa in 75 consecutive circles was counted in a similar experiment, an operation which took 2¼ hr., the average speed was found to be 111 μ/sec., with a standard error of 24·5. The actual average speed of the suspension, measured by the slow projection method mentioned above, was 117 μ/sec.



Relationship between s^2, the square of the standard error of $\bar{c}$, and τ, the time interval, in seconds, between consecutive sperm counts. The scale of τ varies according to r, the radius of the circle in which sperm counts are made; $\bar{n}$ is the average number of sperm in the circle; $\bar{c}$, the estimate of the average speed of the sperm suspension, is assumed to be 110·5 μ/sec. Number of sperm counts, 75. The point P refers to a 0·27-sec. time-interval between counts, on the r = 50 μ τ scale

The square of the standard error, s^2, is calculated by means of the formula:

$$s^2 \doteqdot \frac{\bar{c}^2}{k\bar{n}(x \ln x)^2}\left\{\frac{\bar{n}(1-x)^2(3+x)}{(1+x)}+x(1-x)\right\}, \quad (2)$$

where k is the number of counts and $x = \exp -(\bar{c}\tau/1{\cdot}5708\, r)$.

Equation (2) shows that s^2, which is a measure of the precision of the estimate of the average speed, depends on k, the number of frames on which sperm counts are made, $\bar{n}$, the average number of spermatozoa in a count, and τ, the time interval between successive frames. Assuming 75 sperm counts, the variations in s^2 with τ, for different values of $\bar{n}$ and r, are given in the accompanying figure. These curves are useful for determining experimental conditions. Suppose, for example, that the average speed of spermatozoa is about 110 μ/sec. and that it has been decided to make 75 counts of the number of spermatozoa in circles of radius 50 μ, the number in these circles being about 12. The time interval of 0·27 sec. between photographs will make $s^2 = 567$ ($s = 23{\cdot}8$) if $\bar{n} = 12$, which was approximately the value obtained in the experiment mentioned above. The disparity between this value of s, 23·8, and the earlier value, 24·5, is explicable but unimportant in this context.

A quantitative method of measuring the average speeds at which spermatozoa swim may be of importance in the investigation of human sterility, in the artificial insemination of livestock, and in academic studies on the physiology and biochemistry of spermatozoa. The method described in this communication is still in its infancy, in the sense that further trials are needed to test its efficacy and the extent to which suspensions of spermatozoa approximate in their behaviour to the model upon which the principle of probability-after-effect is based. A fuller account of the theory and practice of the method will be published in the *Journal of Experimental Biology*.

This work is supported by the Medical Research Council.

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[2] Rothschild, Lord, *J. Exp. Biol.*, **25**, 219 (1948).
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LIMITING PRODUCTS IN THE PHOTOLYSIS OF ACETALDEHYDE AT HIGH INTENSITY

By M. A. KHAN, Prof. R. G. W. NORRISH, F.R.S., and Dr. G. PORTER

THE study of the photolysis of acetaldehyde[1,2] has led to the conclusion that the primary photochemical change is compounded of two reactions, the relative incidence of which appears to be dependent on wave-length:

$$CH_3CHO + h\nu = CH_4 + CO \quad (1a)$$
$$CH_3CHO + h\nu = CH_3 + CHO \quad (1b)$$

Investigation at elevated temperatures has revealed the onset of a chain reaction, the quantum yield rising from a value less than unity at 25° C. to 300 at 300° C., for which Leermakers[1] proposed the following scheme, derived from reaction (1*b*):

$$CH_3 + CH_3CHO = CH_4 + CH_2CO \quad (2)$$
$$CHO + CH_3CHO = CO + H_2 + CH_3CO \quad (3)$$
$$CHO + CH_3CHO = CO + CH_4 + CHO \quad (4)$$
$$CH_3CO = CH_3 + CO \quad (5)$$
$$2CH_3 = C_2H_6 \quad (6)$$
$$CH_3 + CHO = CH_4 + CO \quad (7)$$

At the lowest temperatures and highest intensities investigated, however, it has been found impossible to detect any ethane at all, even by mass-spectrometric analysis[3], though in the reaction above 100° C. small amounts have recently been observed mass-spectrometrically[4,5].

On this account, and on the basis of further analytical results at temperatures below 100° C., Blacet and Blaedel[6] replaced the chain-ending reaction 6 by a recombination of acetyl radicals, leading to the formation of diacetyl, which was detected in roughly the expected amount. There seems little doubt about the correctness of their conclusions. If, however, a sufficiently high concentration of methyl radicals could be generated by reaction (1*b*) the incidence of reactions (6) and (7) should predominate over that of reaction (2), since the rates of the former are proportional to the second power of the concentrations of radicals and that of

the latter to the first power. There is one other second-order radical reaction resulting in non-condensible products to be considered:

$$2CHO = 2CO + H_2, \qquad (8)$$

which, like the other reactions of formyl, may proceed via hydrogen atoms without affecting the present discussion. At limiting high intensities, when terms involving $I_{abs}^{-\frac{1}{2}}$ become negligible, reactions (1)–(8) lead to the following expression for the ratios of products formed in unit time:

$$\frac{CH_4}{C_2H_6} = \frac{CH_4}{H_2} = \frac{2k_a}{k_b} + \frac{k_7}{\sqrt{k_6 k_8}}\left(1 + \frac{k_a}{k_b}\right).$$

We have investigated the photolysis of gaseous acetaldehyde at 20° C. and at intensities of the order of 6×10^{-3} $Nh\nu$ cm.$^{-3}$ sec.$^{-1}$, using the full radiation of the gaseous flash discharge[7]. We have found that not only is ethane a major product of the reaction but also that the ratio $(CH_4)/(C_2H_6)$ is independent of intensity. Previous photochemical studies at flash intensities have shown that the rise of temperature resulting from the adiabatic nature of the reaction is of major importance[8,9], and it was therefore first necessary to eliminate this complication. This was done by reducing the energy/flash and by addition of inert gas (carbon dioxide) until further addition had no effect on the products. The accompanying table gives the proportions of gaseous products as a function of relative intensity, obtained by photolysing 60 mm. acetaldehyde in the presence of 480 mm. carbon dioxide.

Relative intensity	$\frac{CH_4}{CO}$	$\frac{C_2H_6}{CO}$	$\frac{CH_4}{H_2}$	$\frac{CH_4}{C_2H_6}$
1·0	0·44	0·21	1·8	2·1
2·4	0·45	0·21	1·9	2·1
5·0	0·45	0·20	1·9	2·2
23	0·50	0·22	1·7	2·3
40	0·47	0·20	1·6	2·3
69	0·45	0·21	1·5	2·1

Over a seventy-fold intensity-range, the ratio CH_4/C_2H_6 is constant to $\pm$ 5 per cent. As ethane can scarcely arise from any reaction other than (6), it follows that reaction (2) does not occur to any significant extent in the intensity-range investigated. Direct confirmation of the absence of reaction (2) was obtained in the following way. A mixture of diacetyl and acetaldehyde in the ratio 1 : 3 was photolysed in excess carbon dioxide using wave-lengths absorbed by diacetyl alone but at an intensity giving rates of decomposition comparable with the above. The decomposition of diacetyl results in the formation of methyl and acetyl radicals[10], and if reaction (2) occurs, methane will be formed. It was found that the gaseous products were ethane and carbon monoxide exclusively. When the same mixture was decomposed by a conventional mercury arc source, again using radiation absorbed only by diacetyl, methane became the major hydrocarbon product. This confirms that the methane found in the high-intensity experiments with acetaldehyde does not arise from reaction (2), in agreement with our conclusions based on the constancy of product ratios.

Our results lead immediately to the following conclusions about the mechanism of this reaction:

(1) For the full wave-length radiation used, $k_a/k_b \ll 1{\cdot}1$.

(2) Since the minimum possible value of k_a/k_b is zero, it follows that $k_7/\sqrt{k_6 k_8} \ll 2{\cdot}2$. Now it is known that the rate constant of the bimolecular chain termination step in the high-temperature photolysis corresponds to unit collision efficiency[11], and it has been concluded that this refers to reaction (6) or (7). If this is so, it follows that the recombination of methyl radicals occurs with a collision efficiency very near unity, since if the constant measured is k_7, both k_6 and k_8 must be nearly equal to k_7, because neither k_6 nor k_8 can exceed the measured value of unit efficiency.

(3) In view of the large proportion of ethane obtained in these experiments, the total absence of ethane at low intensities must be attributed to reaction (2). In this case the fact that chains are not propagated must be accounted for by the statement that in the low-temperature photolysis of acetaldehyde the rate-determining step is not reaction (2) but the decomposition of the acetyl radical by reaction (5).

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NEGATIVE-ION FORMATION IN GASES OF HIGH DIELECTRIC STRENGTH

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It is widely known that certain polyatomic molecular gases, for example, sulphur hexafluoride, carbon tetrachloride and CCl_2F_2, possess appreciably higher breakdown voltages than certain common gases, such as oxygen, hydrogen and nitrogen, for a wide range of electrode arrangements, gap-spacings and pressures. In an earlier communication[1], we have mentioned some of the relevant papers, to which the following should be added for data on breakdown voltages: Camilli and Chapman[2] for data on SF_6, CCl_2F_2, $CClF_3$, CF_4, $CHClF_2$ and CHF_3; Geballe and Linn[3], CSF_2; Wilson, Simons and Brice[4], C_2F_6, C_4F_{10} and C_5F_{12}; and Kowalenko[5], HCl, HBr and HI. Burhop, Massey and Watt[6] give dissociation data on UCl_4 and UF_6. The dielectric (breakdown) strengths are those measured at pressures of approximately 1 atmosphere in short gaps, for example, between spheres when the spacing is much less than the sphere diameter, where the electric field is approximately uniform.

The purpose of this communication is to extend the discussion given earlier[1] and to present new experimental results on dissociation processes, notably in sulphur hexafluoride.

It is clear[1] that the formation of negative ions during the breakdown process in a gas will tend to

reduce, other things being equal, the value of Townsend's α coefficient (particularly for low X/p), as Geballe and Harrison[7] have recently suggested for oxygen, and as Penning[8] had earlier pointed out (see also Massey[9], pp. 66, 103). Penning showed how attachment coefficients could, on certain assumptions, be deduced from $\alpha/p - X/p$ data.

Thus, since α is the predominating single factor governing breakdown, higher dielectric strengths would in general be expected for gases showing appreciable electron attachment. This general argument needs further examination, however, since chlorine has, in the conditions of the first paragraph above, a relative dielectric strength (cf. nitrogen) of about 1·5, while appreciably higher values are known for carbon tetrachloride, 6·3–6·4, and certain other gases[1]. Further, carbon tetrafluoride has a relative dielectric strength of only 1–1·1, whereas sulphur hexafluoride has a value of 2–2·5.

Consider, therefore, the following simplified outline of processes of negative-ion formation by electron impact[9], where Y has a positive electron affinity :

$$\left.\begin{aligned} &XY_n + e \rightarrow XY_{n-1} + Y + e \\ &\text{followed by the separate process,} \\ &Y + e \rightarrow Y^- \end{aligned}\right\} \quad (1)$$

$$XY_n + e \rightarrow XY_n^{-*} \rightarrow XY_{n-1} + Y^- \quad (2)$$

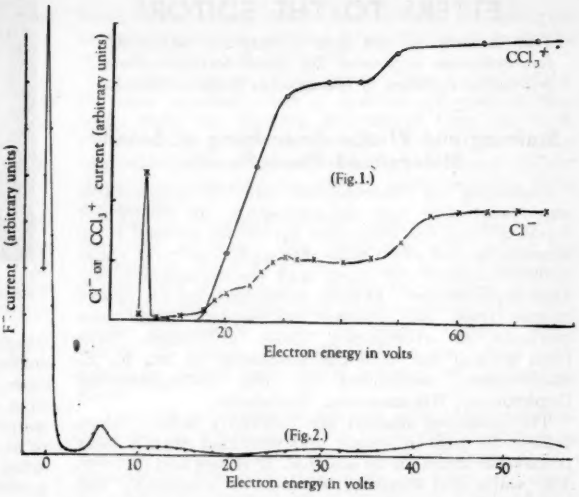
$$XY_n + e \rightarrow XY_n^{-*} \rightarrow XY_n^- \quad (3)$$

$$XY_n + e \rightarrow XY^+_{n-1} + Y^- + e \quad (4)$$

Reaction (3) becomes operative at pressures where three-body collisions are probable, whereas (2) is a two-body process. Process (1) doubtless occurs, as Mohr and Weissler[10] indirectly suggest, but the cross-sections would probably be low (Massey[9]) compared with those for processes (2) or (3) and (4). Further, the dielectric strength of chlorine, in which process (1) would be expected to occur at least as strongly as in carbon tetrachloride, is inconsistent with process (1) as the major mechanism. It is also difficult to explain the relative dielectric strengths of carbon tetrafluoride and sulphur hexafluoride on process (1) by itself.

As a preliminary step in the study of electrical breakdown in such gases, we have studied the dissociation patterns due to electron bombardment in a Nier mass-spectrograph source, in CCl_4, CCl_3F, CCl_2F_2, $CClF_3$, CF_4, SF_6 and in certain other gases. The negative-ion abundances found in the first five of these gases are consistent with the relative dielectric strengths. Figs. 1 and 2 show negative-ion current/electron energy curves for carbon tetrachloride (showing processes (2) and (4)) and sulphur hexafluoride (process (2) only). The Cl^- curve in Fig. 1 probably rises again near zero electron energy, and SF_6 shows large SF_5^- and SF_5^- currents (process (3)), as first shown by Ahearn and Hannay (to be published). Vought[11] shows a similar curve for $SiCl_3^-$ from silicon tetrachloride. It is likely that the co-existence of processes (2) and (4) would tend to give higher dielectric strengths than process (2), of the same probability, by itself.

The extent to which the low-pressure ($\sim 10^{-5}$ mm. mercury) data on process (2) apply to swarm conditions depends on the probability with which XY_n^- reverts to XY_n (cf. process (3)). This should be unimportant if the electron affinity of Y is greater than the appropriate bond-strength (Massey[9], pp. 47 and 64) ; but space does not permit of a further discussion of this and other related problems.



Variation of negative ion and positive ion currents with electron energy in (1) carbon tetrachloride and (2) in sulphur hexafluoride

Information on the relative importance of processes (2) or (3) and (4) in gaseous breakdown might be obtained by measurements on the dielectric strengths of appropriate mixtures of xenon with sulphur hexafluoride, or with a gas giving processes (2) or (3) and (4), since the ionization potential of xenon is below the critical potential for process (4) in certain of the gases listed above.

The full quantitative testing of the importance of electron-attachment processes in the determination of Townsend's α needs measurement of the basic quantities involved therein[12] together with sparking potential measurements at the same pressures. The quantities are : electron-drift velocity, ionization cross-sections so measured as to include the effect of attachment cross-sections, and the electron energy distribution function[13]. It is thought to be more feasible to evaluate the attachment coefficients from measured values of Townsend's α and to compare them with attachment coefficients measured in the same swarm conditions.

We are greatly indebted to Prof. H. S. W. Massey for advice in the preparation of this communication.

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LETTERS TO THE EDITORS

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Staining and Plastic Embedding of Small Mineralized Plant Fossils

Oospores of charophytes are of considerable importance for age determination of freshwater deposits from the Devonian up to the present time. Minuteness and often indistinct sculpture make them difficult objects for study and photographic reproduction, however. During investigations on charophytes from the Triassic of Sweden, some new methods of overcoming these difficulties have been worked out with the assistance of Mr. K. E. Samuelsson, technician of the Palæobotanical Department, Riksmuseum, Stockholm.

The oospores studied are distinctly polar bodies, 0·25–0·50 mm. in length and provided with a faint transverse striation by alternating ridges and furrows. The walls and contents are almost completely calcified; the oospores are therefore semi-translucent and whitish. Observations on sculpture and photographic reproduction are accordingly extremely difficult without previous preparation.

Good results have been obtained by embedding the oospores in plastic after staining them. Plastic has been used for palæobotanical purposes by Leclercq and Discry[1] to elucidate the anatomical structure of larger fossil plants. Two methods were described: in one methyl methacrylate at high pressure and high temperature was used; in the other the object was embedded in a plastic termed 'Marco 26 C' after immersion in alcohol and styrene. A similar method was described by Purves and Martin[2] and was used by Croft[3] for charophyte oospores. The specimens were embedded in 'Marco' resin and ground sections were prepared for studies on the anatomy. When preparing orientated thin sections of various microfossils, Meyer[4], Levinson[5], Emiliani[6] and Kremp and Johst[7] obtained good results with the aid of certain thermoplastics. For the same purpose, Cummings[8] embedded foraminifers in blocks of 'Marco' resin which were cut into smaller pieces, polished, ground down and sectioned.

In the material now studied the oospores were first thoroughly cleaned from fat by immersion in ether. The cleaning is essential because fats lead to irregular distribution of stain; also they may obscure the oospore sculpture, and make the preparation of ground sections difficult by preventing contact between the plastic and the object. Certain specimens were directly stained after cleaning. Generally, the calcite surface is too compact to be stained effectively, however; because of that, the oospores were immersed in a saturated sodium hydroxide solution for some minutes before staining. Etching in a weak solution of acetic acid for a short time also gave good results. After this treatment, the sculpture often revealed a different susceptibility to the dyes used, the furrows becoming deeply stained, the ridges retaining their natural semi-translucent surface. Sometimes, the oospore surface became stained throughout. In some cases, all efforts to stain oospores gave negative results. Hæmatoxylin and methylene blue were found to be the most satisfactory.

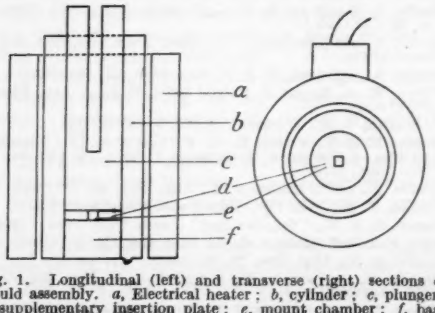

Fig. 1. Longitudinal (left) and transverse (right) sections of mould assembly. *a*, Electrical heater; *b*, cylinder; *c*, plunger; *d*, supplementary insertion plate; *e*, mount chamber; *f*, base plate

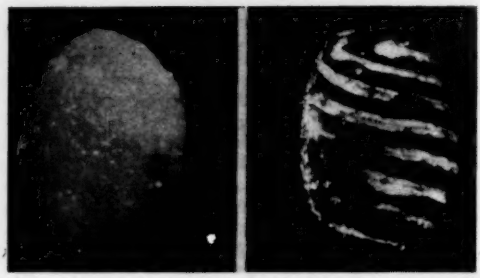

Fig. 2. Oospore of Triassic charophyte not prepared (left), and embedded in polyvinyl chloride after hæmatoxylin staining (right). × 80

For the embedding, an *AB* specimen-mount press equipment (Buehler, Ltd., Chicago) was used. The object is placed on a bed of the plastic powder used (vinyl chloride) on the base-plate of the mould assembly, and covered by plastic powder. The mould assembly is inserted into the press; at a temperature of 120–150° C. and a pressure of 3,500–4,000 lb., polymerization takes place. The specimen is now mounted in a short plastic cylinder, 25 mm. in diameter, and about 10 mm. high. If the polar axis or the equatorial diameter of the oospore has been placed parallel to the upper surface of the cylinder, longitudinal or transverse ground sections can be made according to the usual palæobotanical technique. Due to the toughness of this kind of plastic as compared with the object embedded, ground sections down to 10–15 μ are easily prepared.

It has been observed that the sculpture, when faint, will appear comparatively distinct after embedding. Due to the cylindrical mounting, the oospore can be photographed in two lateral aspects only, or in apical and basal view. Efforts to remove segments of the cylinder followed by polishing of the new surface obtained have been unsatisfactory because of the soft plastic used. Irregularities in the surface and remnants of grinding material pressed into the plastic could not be avoided. For those reasons, an additional part of the mould assembly has been constructed, consisting of a circular insertion plate of the same physical properties as the mould cylinder and closely fitting into the latter. In the middle, the plate has a cubical chamber with sides 7 mm. long. The specimen to be embedded is orientated in the plastic powder to get the polar axis parallel to the upper surface of the cube; pressing and polymerization take place in the usual way. The specimen can be observed and photographed in six aspects, as the highly polished steel walls of the chamber prevent any irregularities in the cube surface.

The oospore can be removed from the plastic by various solvents, among which acetone at a tempera-

ture of 50° C. has been found preferable. No damage to specimens has been observed on embedding or dissolution. The plastic cube must not be placed in cold acetone, however, as it makes deep fissures in the plastic and may spoil the oospore. The whole procedure of embedding, polymerization and cooling-down takes about twenty minutes.

One advantage of the method described is that on account of the high light transmission of the plastic the faint sculpture is visible. Further, the difficulty is avoided of handling small strongly polar objects which must be inspected or photographed in a certain view, for example, a needle-shaped specimen from the apex. The method can be used for various small objects, where sculpture is essential and orientation difficult.

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A New Electron Multiplication Process

IF electrons move through a gas in an electric field, their number can increase if they ionize gas molecules by collision—the well-known Townsend avalanche. Recently, it has been shown[1] that in high-frequency electric fields at very low pressures the number of electrons increases, due to the impinging of electrons on the walls of the vessel and the release of secondary electrons. This is a 'wall multiplication' process which can lead to breakdown.

We have investigated the high-frequency breakdown of neon in cylindrical glass vessels with external electrodes. At pressures greater than 50 mm. mercury and frequencies less than, or equal to, 10^7 c./s., the peak value of the starting field was found to be surprisingly low, corresponding to $X/p = 0{\cdot}6$ V./cm. per mm. mercury[2]. The energy an electron can acquire is then so small that electron multiplication by collision is negligible. Thus we propose the following mechanism: the first electron which is accelerated by the field will have a much greater number of exciting than ionizing collisions, the more so the lower is X/p. Normal excited atoms (emitting resonance quanta within approximately 10^{-8} sec.) and metastable atoms will be produced. Only a few of the latter will reach the walls, because they are destroyed by collisions in the gas and also emit resonance quanta. These strike the ends of the vessel either directly or after being absorbed and re-emitted by other atoms. There they release photoelectrons which will be accelerated, etc. We have here what could be termed a 'quantum avalanche), which releases photoelectrons from the wall in increasing numbers.

In order that an initial electron may be multiplied, it must produce such a number of quanta that more than one electron is released from the wall. Calculations using the meagre data of excitation probabilities[3] and the estimated photoelectric yields[4] make the suggested mechanism likely to occur from 10^7 to 50 c./s.

After this initial process, once the number of electrons is large, gas ionization can occur by electron collision in stages; that is, fast electrons (> 17 eV.) strike neon atoms to produce excited or metastable atoms, and slow electrons (> 5 eV.) strike metastable atoms to ionize them. With traces of argon a metastable neon atom can ionize an argon atom by a collision of the second kind.

The new avalanche is distinct from multiplication processes in which ionization by electron collision in the gas is accompanied by electron emission at the cathode by ions and quanta, as has been suggested to explain the breakdown of krypton and xenon[5] and recently of atmospheric air and nitrogen[6].

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Crystal Structure of Barium–Strontium–Calcium Triple Carbonate

IT has already been found that calcium carbonate exists in one stable form, β-$CaCO_3$ (calcite), and two unstable forms, λ-$CaCO_3$ (aragonite) and μ-$CaCO_3$ (or vaterite), in the ordinary temperature range. Aragonite is formed if precipitation is carried out at a temperature approaching the boiling point of water (higher than 85° C.), whereas when precipitation is carried out at room temperature only calcite results. The third form of calcium carbonate, μ-$CaCO_3$, is formed by precipitation at 60° C.[1].

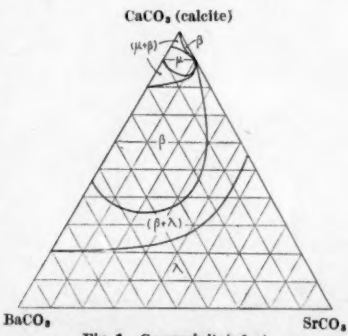

Fig. 1. Co-precipitated at 25–30° C.

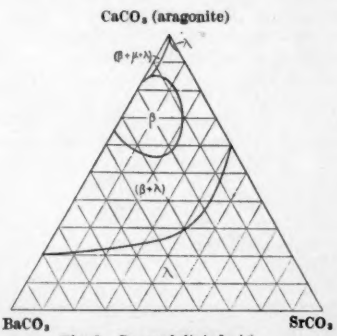

Fig. 2. Co-precipitated at 90–105° C.

Barium carbonate and strontium carbonate have only one stable form (aragonite-type structure) and in both cases temperature of precipitation has no effect on crystal form.

We have co-precipitated the triple carbonate by dropping 1 *N* sodium carbonate solution into a 1 *N* solution of the nitrates of barium, strontium and calcium mixed in the desired proportions and efficiently stirred. These crystalline powders were then examined by an X-ray Geiger counter spectrometer employing copper *K*-radiation.

Figs. 1 and 2 show the variation of crystal structures with molecular composition which we have found at low temperature of precipitation (25° – 30° C.) and at high temperature (90° – 105° C.) respectively. In all, about a hundred and twenty co-precipitated carbonates have been studied, and there have been found three types of solid solutions : aragonite type (λ-carbonate), calcite type (β-carbonate) and vaterite type solid solution (μ-carbonate)[3]. It is noticeable that in the presence of a small amount of isomorphous barium ion, calcium carbonate forms β-carbonate even at a high temperature of precipitation, whereas at low temperature it forms μ-carbonate.

At present no direct correlation between the carbonate structure and the properties of thermionic emission from the BaO–SrO–CaO system obtained by Grey[3] can be offered; but an investigation of the conversion process of triple carbonate to oxide and other experiments are in progress.

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Activation of Lithium Iodide by Europium

A single crystal of lithium iodide activated with an impurity of 0·05 mol. per cent europous chloride has been grown from the melt and found to be a relatively efficient scintillator. The crystal is clear and transparent except for a slight non-uniform purple coloration. Under 2537 A. ultra-violet excitation the luminescence is a strong blue very like that of anthracene. A section of the boule was cut and finished with 320-grit abrasive paper into a cylinder of 2 cm. diameter by 1·5 cm. long. The finished crystal was mounted in an atmosphere of dry nitrogen within a polished aluminium reflecting-cup[1] sealed at the open end with a 'Lucite' light-piper and joined to a 5819 photomultiplier.

The luminescence efficiency for γ-rays was found to be 36 per cent that of sodium iodide (with thallium). The decay time constant of the phosphor is 2·0 μsec. The resolution of the photoelectric line in the pulse height spectrum for cæsium-137 γ-rays was observed to be 14 per cent (full width at half maximum).

Fig. 1 is the pulse height spectrum produced by slow neutrons on lithium iodide (with europium). Neutrons obtained from a polonium–beryllium source were moderated in paraffin; the γ-rays from the source were shielded from the crystal with 3 in. of lead. The spectrum exhibits a resolution of 6 per cent for the 4·785-MeV. products of the $^6Li(n,\alpha)^3H$ reaction.

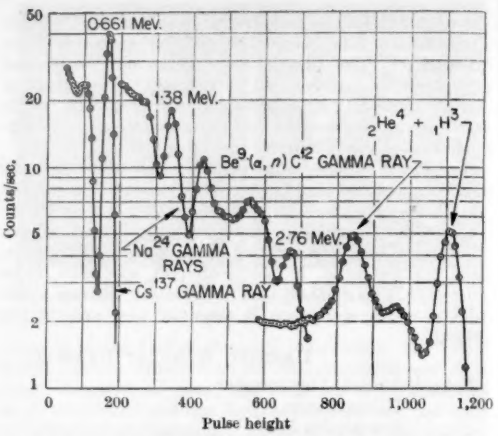

Fig. 1. Pulse height spectrum produced by slow neutrons on lithium iodide (with europium)

Fig. 2 shows the pulse spectra obtained when the crystal was separately irradiated with (*a*) γ-rays from cæsium-137, (*b*) γ-rays from sodium-24, and (*c*) γ-rays and neutrons from a polonium–beryllium source. A partial shield of B_4C was placed between the moderated neutron source and the crystal in order to attenuate the neutron peak so that it would not interfere with the γ-ray peak. The energy calibration was determined from the known values of the sodium-24 γ-rays[2]. A calibrated pulse generator was used to obtain corrections for slight deviations of the apparatus from linearity.

The peak at 843 pulse height divisions (3·40 MeV.) results from the production of electron-positron pairs in the crystal by the γ-rays from the polonium–beryllium source. Previous measurements at this laboratory[2] have indicated a slightly higher value (3·44 MeV.) for this 'pair peak'. The peak at 1,126 divisions (4·55 MeV.) is due to the $^6Li(n,\alpha)^3H$ reaction

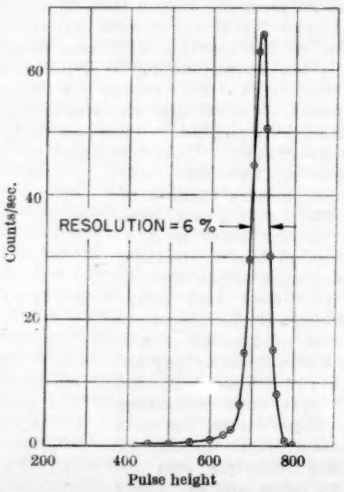

Fig. 2. Spectrum of pulses from lithium iodide (with europium) when exposed to radiations from cæsium-137, sodium-24 and polonium–beryllium neutron source surrounded with paraffin

inside the crystal. Since the Q-value of the reaction is 4·785 MeV., it appears that the efficiency of this crystal is somewhat reduced for heavily ionizing particles.

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Measurement of Activated Diffusion of Adsorbed Molecules

IN continuation of a previous study[1] on the contribution of 'surface diffusion' to the transport of adsorbed molecules within porous adsorbents, rates of adsorption of n-butane have been measured.

For this purpose, a small metal beam balance was constructed which could be operated under high vacuum conditions. The weighing was performed with movable riders manipulated by means of external controls through ground joints in the enclosing glass tube. The beam was 5 cm. long and fitted with agate knife edges. A sensitivity of $\tan\alpha = 0{\cdot}022$ per 1 mgm. was achieved. The pan carrying the adsorbent was hung on a thin glass rod 30 cm. below the balance and was surrounded by a glass tube inserted in a temperature bath. In the present investigation, an electronically controlled low-temperature thermostat[2] was used with 'dry ice' as refrigerant. Any given temperature in the range from room temperature to − 80° C. could be maintained within ± 0·1° C. for any desired period.

In order to simplify the mathematical treatment of the diffusion problem, rates of adsorption were measured at constant pressures. These were maintained by adsorbing a certain quantity of butane at a convenient temperature, say, 0° C., on an amount of silica gel 100–500 times greater than that of the adsorbent under investigation on the balance.

After proper degassing, the adsorbent was cooled to the desired temperature and the balance system then connected to the constant-pressure device. The increase in weight of the adsorbent (4–125 mgm.) was followed with time, until equilibrium was reached. At − 14° C. this occurred in about three hours, while at the lowest temperature (− 79·5° C.) experimental periods were as long as 30 hr. From a plot of w_τ/w_∞ versus time (w_τ and w_∞ are weight increases at time τ and at equilibrium), overall diffusion coefficients could be evaluated using a solution of the general differential equation of diffusion for a system of finite length and for the particular boundary conditions. The range $w_\tau/w_\infty = 0{\cdot}4$ to 0·6 was chosen to give representative values for the diffusion coefficient.

Rates of adsorption of n-butane in porous silica plugs were measured at various temperatures (− 14° to − 80° C.), porosities ($\varepsilon = 0{\cdot}72$ to 0·53) and surface coverages ($y/y_m = 0{\cdot}37$ to 6·9, where y_m is monolayer capacity in millimoles/gm.). The plugs (0·3 gm.) were formed by compressing Linde silica (300 m.²/gm.) into small steel cylinders, thus allowing adsorption to occur only through one plane.

In order to demonstrate the feasibility of the above method and to indicate the bearing of surface diffusion on molecular transport in porous media, some of the results obtained may be quoted. For a plug of porosity 0·53 and a surface coverage of $y/y_m = 0{\cdot}9$, the following overall diffusion coefficients were obtained: $7{\cdot}20$, $2{\cdot}33$ and $0{\cdot}64 \times 10^{-5}$ cm.²/sec. at − 14·4°, − 44·2° and − 79·5° respectively. Following Barrer's[3] calculations for the transient state of gas flow into a porous system, these coefficients are corrected for Knudsen streaming. In this way, the corresponding surface diffusion coefficients are obtained: $5{\cdot}04$, $1{\cdot}87$ and $0{\cdot}60 \times 10^{-5}$ cm.²/sec. This indicates that, under the above conditions, 70, 80 and 94 per cent of the total transport is due to the mobility of adsorbed molecules along the surface. From these diffusion coefficients an activation energy of 3,000 cal./mole results, corresponding to 47 per cent of the adsorption energy.

At the lower temperatures, diffusion coefficients vary only slightly with the porosity of the adsorbent, whereas at higher temperatures there is a considerable increase with porosity. In this range the activation energy is also somewhat greater. Diffusion coefficients depend markedly on the surface coverage. For example, at a coverage $y/y_m = 0{\cdot}37$, $\varepsilon = 0{\cdot}72$ and $t = -44{\cdot}5°$ C., an overall diffusion coefficient of $4{\cdot}08 \times 10^{-5}$ cm.²/sec. was obtained. This increased steadily with greater coverage and reached a maximum value of $8{\cdot}56 \times 10^{-5}$ cm.²/sec. in the multilayer region at $y/y_m = 3{\cdot}0$, whereafter it decreased.

As a whole, these results are in agreement with those obtained in experiments based on a steady-state flow method, as recently reported by Carman[4].

I wish to thank Dr. P. C. Carman, who made the permeability data necessary for the calculation of the Knudsen streaming available to me. This communication is published with the permission of the South African Council for Scientific and Industrial Research, Pretoria.

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Activity Data and the Association of Hydrogen Chloride in Concentrated Solutions

IN some experiments in which concentrated solutions of hydrochloric acid were employed it was necessary to consider the part played by associated hydrogen chloride in determining its properties. Examination of data on the activity of hydrogen chloride[1] showed that the curve relating mean activity (a) to concentration (c) was continuous throughout, although its slope increased markedly at about 2 N.

Up to 4 N the activity coefficient γ is given with reasonable accuracy by the semi-empirical relationship:

$$\log\gamma = \frac{-Ac}{1+Bc} + Dc + Ec^2 - \log(1 + 0{\cdot}036m) \quad (1)$$

c (N)	0° C.				20° C.			50° C.		
	log γ obsv.	$'c$	$10^3 \times K$	$10^3 \times K^1$	log γ obsv.	$'c$	$10^3 \times K^1$	log γ obsv.	$'c$	$10^3 \times K^1$
5	0·44	4·5	3·20	2·5	0·39	4·4	3·1	0·30	4·4	3·2
6	0·59	5·4	1·38	2·1	0·52	5·2	3·0	0·42	5·3	3·0
7	0·74	6·1	0·79	2·4	0·66	5·9	3·2	0·53	6·0	2·8
8	0·89	6·8	0·44	2·6	0·79	6·6	3·2	0·65	6·7	3·0
9	1·03	7·4	0·15	2·9	0·93	7·3	3·2	0·76	7·2	3·5
10	1·17	8·0	0·14	3·1	1·05	8·0	3·1	0·87	7·8	3·6
Mean K^1				2·6			3·1			3·2

where $c/m = a_1 - b_1 m$, and A, B, D, E, a_1 and b_1 are constants that have been evaluated by Harned and Owen[2].

Above 4 N the observed values of γ are less than would be expected from the above relationship. If deviations are due to association into an ion pair or a truly associated type, the values of the concentration interpolated from the curve relating calculated log γ and c, using log $\gamma_{obsv.}$, might be assumed to be the actual concentrations of the free ions.

Fig. 1 shows the curves for log γ against c calculated from the above relationship for $c = 4 - 10\,N$ at 0°, 20° and 50° C. The experimental values of log γ were then interpolated from these curves to give values of $'c$ corresponding to the free ion concentration (see table).

Consider now the equilibrium:

$$H^+ + Cl^- = HCl$$

$$K = \frac{c - {}'c}{{}'c^2} \cdot \frac{\gamma_{HCl}}{\gamma_{Cl^-} \cdot \gamma_{H^+}} = \frac{c - {}'c}{{}'c^2} \cdot \frac{\gamma_{HCl}}{\gamma^2_{\pm HCl}}, \qquad (2)$$

where c is the total hydrogen chloride concentration.

If this association were of the normal type as understood in the case of acetic acid, then $\gamma_{HCl} \sim$ constant $= 1$ at $c = 0$. However, this assumption leads to values of K that are not constant (see table). Making the further assumption that, as for acetic acid in dilute solution, either $\gamma_{H^+} = \gamma_{Cl^-} = \gamma_{HCl} = 1$, or $\gamma_{HCl} = \gamma^2_{\pm HCl}$, a constant $K^1 = \frac{c - c^1}{{}'c^2}$ (see table) is obtained. The values of K^1 are remarkably constant and show little variation with temperature, indicating that $\Delta S_{ass.HCl} \approx 0$ and $\Delta F_{ass.HCl} = \Delta H_{ass.HCl} = 2{\cdot}1$ k.cal./mole.

According to equation (2), K/γ_{HCl} can be calculated from the data in the table; extrapolation to $c = 0$ gives K. Theory[3] and experiment[4] demonstrate a linear relationship between log γ and c in dilute solutions. The extrapolation was therefore carried out as shown in Fig. 2[5].

Values of K thus obtained were, within extrapolation error, independent of temperature and had a value $K_{c=0} = 0{\cdot}056$, being in reasonable agreement with the value of K^1; the corresponding value of $\Delta H_{ass.HCl} = 1{\cdot}7$ k.cal.

The above calculations seem to indicate the validity of the assumption that $\gamma_{HCl} = 1$ and the alternative relationships $\gamma_{Cl^-} = \gamma_{H^+} = \gamma_{HCl}$, or $\gamma^2_{\pm HCl} = \gamma_{HCl}$.

The figures for K and K^1 are in accord with that found for nitric acid by light absorption experiments[5], namely, $K_{c=0} = (5 \pm 1) \times 10^{-2}$. The agreement is to be expected, for these two acids have similar strengths.

Available thermochemical data[6] reveal a considerable fall in the heat of formation of solutions of hydrogen chloride at about 2 N, becoming much more marked at 5 N onwards. The data for sodium chloride and sodium hydroxide do not show a similar fall until higher concentrations are reached, indicating that at 5 N the association in solutions of these substances is relatively small. It is possible to calculate $\Delta H_{ass.HCl}$ in an approximate manner from the equations: $Na^+(5\,N) + H_2O + Cl^-(5\,N) = Na^+(5\,N) + OH^-(5\,N) + HCl(H^+,Cl^-, + HCl_{a.s.} = 5\,N) + 15{\cdot}7$ k.cal., and $H_2O = H^+ + OH^- + 13{\cdot}7$ k.cal.

If there were no association of the hydrogen chloride, the heats of these reactions should be identical. The difference $\Delta H_{ass.HCl} = 2{\cdot}0$ k.cal. is in good agreement with the above.

I should like to express my thanks to Sir Eric Rideal for his help and advice. The above forms a part of a research pro-

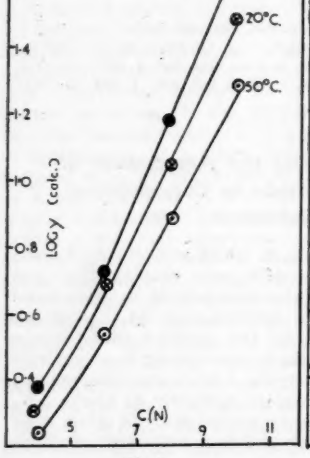

Fig. 1

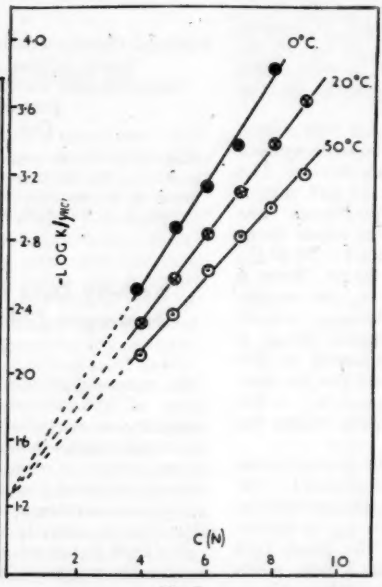

Fig. 2

Fig. 1. log $\gamma_{calc.}$ plotted against the HCl normality. ●, 0° C.; ⊗, 20° C.; ⊙, 50° C.
Fig. 2. $-\log K/\gamma_{HCl}$ plotted against the HCl normality. ●, 0° C.; ⊗, 20° C.; ⊙, 50° C.

gramme that is being sponsored by the British Electricity Authority, to which due acknowledgment is made.

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Reaction Kinetics of the Cytochrome System

In living wheat roots three cytochromes co-operate, the prosthetic groups of which correspond spectroscopically to the types *a* (= cytochrome oxidase), *c* and *b* of animal preparations. Succinoxidase is the main dehydrogenase system[1]. A factor *X*, characterized by a strong band at 570–575 mμ, is probably linked between succindehydrogenase and cytochrome *b* [1,2]. Studies of the time-course of oxidation, performed by means of a new automatic spectrophotometric technique[1], show a direct electron transference in the sequence succindehydrogenase → *X* → *b* → *c* → *a* → oxygen. The process of oxidation of the reduced cytochromes is a first-order reaction in accordance with the overall formula $Fe^{2+} \rightarrow Fe^{3+} + e$. The molar velocity of oxidation, calculated as $V_e = \frac{1}{\frac{1}{2}t} \cdot c$ ($\frac{1}{2}t$ is time in seconds for the half-way point of oxidation, *c* is relative molar concentration), shows very similar values for all cytochromes (see table), a fact compatible with a uniform electron transference between the reacting cytochromes, these probably being located in a fairly compact structural unit near the surface of the cells (cf. ref. 1).

At normal anion respiration and 19° C., the cytochromes are predominantly oxidized (64–84 per cent; cf. ref. 1). This means that the electron transference only amounts to a small fraction (*c.* 1/10 to 1/30) of the full capacity of a nearly reduced system (0–10 per cent oxidation). This damped activity balances the power of reduction of the succindehydrogenase system. The 'over-dimensioned' capacity of the cytochrome system corroborates earlier experiences as to the low oxygen requirement; wheat roots maintain their full anion respiration at an oxygen tension amounting to only 1/10 to 1/20 of normal aeration (cf. ref. 3).

The re-oxidation of a completely reduced cytochrome system (anaerobical conditions) agrees with $\frac{1}{2}t$ = 10–40 sec. It was found that the diffusion of the oxygen from the medium to the respiring cells is not a limiting factor, whereas the continuous delivery of electrons from succindehydrogenase has a general retarding effect. In absence of succindehydrogenase the re-oxidation would be completed in $\frac{1}{2}$–1 sec.

After a rapid shift from aerated to complete anaerobiosis, the cytochrome oxidase is reduced with $\frac{1}{2}t$ = 10 sec. (approx.), or about the same as for re-oxidation. The reduction of *c* and *b*, however, is

Relative Velocities of Electron Transference (V_e) in the Cytochrome System of Living Wheat Roots. Percentage values in brackets. Relative concentration of *a*, 1; *c*, 2; and *b*, 3·5.

Cytochrome	*a*	*c*	*b*
Reduction (from aerobic to anaerobic)	0·090 (100)	0·032 (35)	0·011 (12)
Re-oxidation (from anaerobic to aerobic)	0·100 (100)	0·100 (100)	0·095 (95)

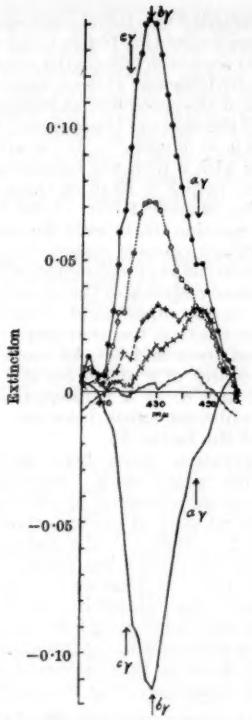

Fig. 1. Oxidation–reduction curves (*s* red.–*s* ox.; cf. ref. 1) of a 15-mm. thick bundle of wheat roots, exposed to increasing anaerobiosis (oxygen-free succinate) and thereafter re-oxidized. The positive curves illustrate the increasing reduction: •—• after 1 min., ×—× after 4 min., +—+ after 7 min., ○—○ after 13 min., and ●—● after 32 min. The negative curve shows the rapid re-oxidation 1 min. after shifting over to aerated solution. Absorption spectrum automatically recorded in intervals of 2 mμ (cf. ref. 1). The very rapid response of the cytochrome oxidase is clearly shown

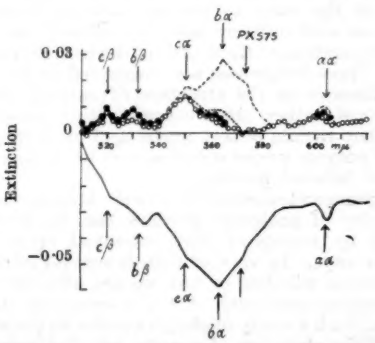

Fig. 2. As in Fig. 1, but comprising the α- and β-bands of the cytochromes. Upper curves, reduction in oxygen-free succinate: ○—○ after 1 min., ●—● after 8 min., – – – after 16 min., and — — — after 32 min. The time order $a > c > b \gg PX\ 575$ is clearly shown. Lower curve shows the re-oxidation in aerated solution

considerably retarded (see table), the molar quantities of these enzymes amounting to five to six times that of *a*. The retarded reduction reflects the much slower rate of the succindehydrogenase system, namely, of the dehydrogenation of the succinate, as compared with the full capacity of the electron transference in the system $X \rightarrow b \rightarrow c \rightarrow a \rightarrow$ oxygen. At re-oxidation the reaction starts with a turnover number of more than 20,000 per min. (which is 10 to 30 times the 'normal' turnover number of about 1,700; cf. ref. 1), whereas at reduction the reaction starts with the moderate speed of the succindehydrogenase system, resulting in the observed retardation of cytochrome *b* with a factor of 9 or 10. The rapid response of the cytochrome oxidase at reduction, on the other hand, reflects the higher velocity of the electron transference, *a* being immediately reduced by *c* and *b*. As previously stated[1] the potential states of *c* and *b* are not so far apart as those of *c* and *a*, as a consequence of which a reversible equilibrium exists between *c* and *b* (and between *b* and the factor *X*).

The interpretation given here of the retarded reduction of the cytochromes *c* and *b* does not support the deductions advanced by Chance as to *b* not lying in the direct path of electron transference from succinoxidase to oxygen[4]. The tissue preparations used by him are obviously less suited for a clear-cut study of the reaction kinetics of the cytochrome system, because the interaction with the systems supplying the succindehydrogenase is broken. It is known that an accumulation of fumarate may reverse the stream of electrons from succindehydrogenase to *b* (and *c*) and completely stop the reduction.

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Relative Specificity of the Chemically Modified '*Aspergillus niger* β-Glucosidase'

The work of Miwa and co-workers[1,2] showed that the relative specificity of β-glucosidase, expressed in terms of the ratio of enzyme activity toward β-glucosides with different aglucons, differs over a wide range depending on the source of the enzyme preparations. These differences are considered to be due to the difference in the structure of enzyme proteins themselves rather than contaminating substances, since they remain almost unchanged upon fractionation of enzyme preparations as well as with preparations of different purity.

In immunochemistry it is well known that the specificity of antigenic proteins can be artificially altered by modifying their chemical structure in various ways. In view of this, it seemed interesting to examine whether or not we are able to modify the relative specificity of the enzyme by chemical means. Such a study might give a clue to the elucidation of the structure of enzyme proteins responsible for relative specificity.

In the present work, β-glucosidase from *Aspergillus niger* was used. This enzyme has been considerably purified in Miwa's laboratory and shown to be a protein with nitrogen content of 15·4 per cent[3]. As chemical reagents capable of modifying the structure of enzyme protein, formalin and nitrous acid were employed.

Enzyme preparation. The method of procedure was similar to that applied by Niwa[3]. Specific activity *f* (phenyl-β-glucoside) was about 25 in glycine–hydrochloric acid buffer of *p*H 3 and 10 in citrate. Niwa carried purification further, but in the present work chemical treatment was carried out with this enzyme preparation redissolved in the concentration of about 2 per cent.

Treatment with nitrous acid. (*a*) One part of 30 per cent sodium nitrite and 0·2 part of glacial acetic acid were added to four parts of enzyme solution. After keeping in a refrigerator for 48 hr. the enzyme was precipitated, washed with acetone and dried *in vacuo* over calcium chloride. A yellow powder was obtained. (*b*) To 10 ml. of a 2 per cent solution of the yellow enzyme powder a small amount of α-naphthylamine was added and kept at 30° C. for 2 hr. The enzyme was precipitated and washed with acetone and dried *in vacuo*. The resulting preparation was red.

Treatment with formalin. (*a*) To seven parts of enzyme solution one part of 30 per cent formalin was added and allowed to stand at 30° C. for 48 hr. Then the enzyme was precipitated with acetone, washed free from formalin and dried *in vacuo*. (*b*) The same procedure as (*a*) was used, except that the ratio of enzyme solution and formalin was 4 : 1 and the duration of incubation was 70 hr. (*c*) The same procedure as (*b*) with incubation of 144 hr.

The accompanying table shows the results thus obtained. It will be seen that relative specificity is affected by the action of nitrous acid or formalin. Changes of the relative specificity of the enzyme treated with nitrous acid are recognizable in *p*-nitrophenyl-, *p*-cresyl- and methyl-β-D-glucosides. This modification of the relative specificity in *p*-nitrophenyl-β-D-glucoside is nearly restored to the original value after treatment with nitrous acid followed by coupling with α-naphthylamine. On the other hand, it has long been postulated that nitrous acid forms nitroso or diazo compounds with protein in addition to deaminizing[4]. Thus, it may be suggested that the modification of the relative specificity is due to the

Relative Specificity of Chemically Modified '*Aspergillus niger* β-Glucosidase'

Substrate: β-D-glucoside of	Original enzyme	Treatment with nitrous acid		Treatment with formalin		
		(*a*)	(*b*)	(*a*)	(*b*)	(*c*)
	f*=9·5	f=3·4	—	f=11·5	f=10·5	f=11·5
	Ratio†	Ratio	Ratio	Ratio	Ratio	Ratio
Phenyl	10·0	10·0	10·0	10·0	10·0	10·0
o-Cresyl	0·6	0·7	—	0·4	—	—
p-Cresyl	11·8	7·8	8·9	9·3	9·9	9·7
Saligenin	4·6	4·5	4·6	1·5	1·2	1·5
Salicylaldehyde	12·5	14·0	12·9	7·6	6·8	7·1
Vanillin	7·1	4·3	—	4·4	3·5	3·9
p-Nitrophenyl	9·7	23·7	14·7	15·0	13·0	15·0
Methyl	2·8	1·5	2·0	2·8	2·8	2·9
n-Butyl	2·5	3·4	3·8	3·2	3·7	3·7

* Specific activity f was calculated from $f = K/g \log_e 2$, where K is a velocity constant of the first-order reaction and g is grams of enzyme in 8 ml. of reaction mixture composed of buffer (*M*/5 citrate, *p*H 3·0), substrate (0·048 *M*) and enzyme solution in the ratio of 1 : 1 : 2. Temperature, 30° C. Phenyl-β-D-glucoside is used as standard substrate for determining β-glucosidase activity.
† The rate of hydrolysis of the phenyl-β-D-glucoside is taken as unity.

change of enzyme structure. On testing formolized enzyme, it is found that the hydrolytic activity against salicin is specifically decreased. Moreover, the relative specificity is affected in the same way and to the same extent with formalin for two, three and six days respectively. These results indicate that chemical reaction is completed at least within two days under these conditions. From the point of view of species specificity of the enzyme, it should be noted that '*Aspergillus niger* β-glucosidase' is resistant to formalin, whereas almond emulsin is very sensitive[5,6]. The reaction of protein with formalin is more complicated than simply the formation of methylene compounds. In any event, free amino groups are blocked in addition to changes in other groups such as indole nuclei and imidazol rings. In the hydrolysis of *n*-alkyl-β-D-glucosides, nearly all the β-glucosidases from different sources exhibit an increase in the ease of hydrolysis with increasing chain-length except in the case of *Aspergillus niger* β-glucosidase[6,7]. In this respect it is significant that, after treatment with nitrous acid or formalin, *Aspergillus niger* β-glucosidase also shows a small increase with increasing chain-length.

There still remains, however, the question whether or not we are able to change greatly the enzymatic properties without losing its activity.

I wish to thank Prof. Tomoo Miwa, of Tokyo Bunrika University, in whose laboratory this work was carried out, for his help and encouragement throughout this investigation.

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Fate of Sodium 2,4-Dichloro-phenoxy-ethyl-sulphate in the Soil

SOME additional aspects of the "Fate of Sodium 2,4-Dichloro-phenoxy-ethyl-sulphate" which Prof. L. J. Audus has discussed[1] may possibly lend further understanding to this interesting problem.

Research on sodium 2-(2,4-dichloro-phenoxy)ethyl-sulphate for the past three years in this laboratory has indicated that the compound is readily hydrolysed under acid conditions to 2-(2,4-dichloro-phenoxy)-ethanol and sodium acid sulphate[2]. It has also been found that the soil organism, *Bacillus cereus* var. *mycoides* (Flügge) Smith, Gordon and Clark, possesses enzymes which can catalyse this hydrolysis[3,4]. The enzymatic conversion occurs in soil as well as *in vitro*[4].

An important point for consideration is the fact that 2-(2,4-dichloro-phenoxy)ethanol, which is quantitatively generated when sodium 2-(2,4-dichloro-phenoxy)ethyl-sulphate is added to soil[4], is a highly potent root growth inhibitor. It is extremely difficult to distinguish between 2,4-D and 2-(2,4-dichloro-phenoxy)ethanol on the basis of root growth suppression.

Although 2-(2,4-dichloro-phenoxy)ethanol can be oxidized to 2,4-D in soil[4], it is yet impossible to ascribe the herbicidal action of sodium 2-(2,4-dichloro-phenoxyl)ethyl-sulphate exclusively to one or the other of these compounds. Under field conditions it is most likely that when sodium 2-(2,4-dichloro-phenoxy)ethyl-sulphate is added to soil, the hydrolysis product 2-(2,4-dichloro-phenoxy)ethanol, as well as any 2,4-D which is generated, can suppress the root development of weed seedlings.

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[1] *Nature*, **170**, 886 (1952).
[2] Carroll, Robert B., *Contrib. Boyce Thompson Inst.*, **16**, 409 (1952).
[3] Vlitos, A. J., *Contrib. Boyce Thompson Inst.*, **16**, 435 (1952).
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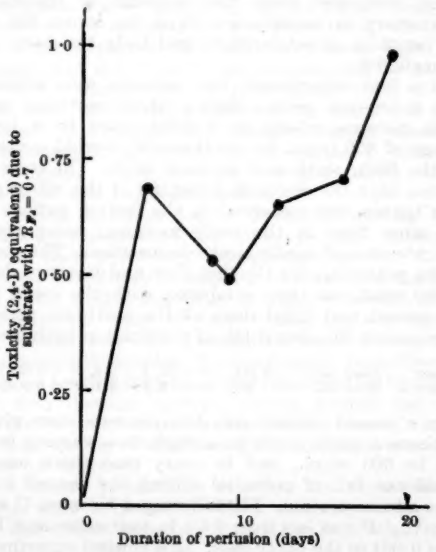
THE possibility that phytotoxicity generated when sodium 2,4-dichloro-phenoxy-ethyl-sulphate is perfused through soil might be due to hydrolysis to a toxic 2,4-dichloro-phenoxy-ethanol has been seriously considered; but I have so far been unable to obtain any evidence that this compound accumulates in the perfusate. The toxicity seems to be due entirely to 2,4-D. Four independent reasons for this conclusion are given in the original paper[1]. The most convincing evidence comes from assays using paper chromatography to separate the toxic compounds in any possible mixture[2]. Only one compound has, as yet, been found in this very sensitive assay, which will detect 10^{-4} γ equivalents of 2,4-D, and this has an R_F value (0·7) identical with that of 2,4-D. A graph showing toxicity changes due to this compound in the perfusate is reproduced herewith. It is extremely unlikely that the ethanol has the same R_F value (solvent: butanol–ammonia) as the 2,4-D, but it has not been possible as yet to check this experimentally. The most rational explanation of the results to date is that the hydrolysis of sulphate to ethanol



is the limiting reaction in the soil and that the shape of the toxicity–time curve is a direct reflexion of the activity of the hydrolysing organism. The further conversion to acid, probably by a different organism, takes place so rapidly that the ethanol intermediate can never accumulate in amounts detectable even by the sensitive assay employed.

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[1] Audus, L. J., *Nature*, **170**, 886 (1952).
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Effect of Cortisone on Tissue Potentials in Man

Since a study[1] of the changes produced by cortisone in the decolorization times of oxidation-reduction dyes injected in the skin gave some grounds for believing that this drug caused a change in the electrode potential (E_h) of the tissues, it seemed desirable to test the hypothesis by direct electrical measurement. The results show that a change in potential does occur, and the method employed offers a simple clinical means of investigating the peripheral action of cortisone and other substances.

A platinum–iridium needle insulated to within a few millimetres of the tip forms the electrode, which is inserted subcutaneously and connected to one arm of an electrometer-type of potentiometer. The other arm of the potentiometer is connected to a calomel half-cell which is dipped in a beaker of saturated potassium chloride solution; the patient places one finger into the same beaker to complete electrical contact with the skin. The potential difference was found to rise slowly during the period following insertion of the needle, so that for purposes of comparison readings should be made at corresponding times, measured from the moment of insertion. Preliminary investigation showed the errors due to the variables of temperature and body resistance to be negligible.

In a first experiment, two patients were studied over a ten-day period during which cortisone was given intramuscularly in divided doses to a total dosage of 600 mgm. in the three-day period covered by the fifth, sixth and seventh days. On each of the ten days the electrode potential of the subcutaneous tissues was measured in the fasting patient at the same time in the early morning, using three separate sites of needle-electrode insertion. The mean of the potentials for the first four and last two days of the trial was then compared with the mean for the second and third days of the cortisone period. There was a significant fall of potential in both cases.

Case 1. Mean fall = 25 mV. ($n = 23$, $t = 5{\cdot}4$, $P < 0{\cdot}001$)
Case 2. Mean fall = 21 mV. ($n = 23$, $t = 4{\cdot}4$, $P < 0{\cdot}001$)

In a second experiment, five patients were given cortisone acetate orally in a single dose varying from 125 to 500 mgm., and in every case there was a significant fall of potential during the second hour after administration. The fall ranged between 17 and 23 mV.; P was less than 0·01 in four cases and less than 0·001 in the other case. In a control experiment using the aqueous vehicle in which cortisone acetate is suspended, no significant change was observed.

The fall in electrode potential of the subcutaneous tissues observed by this method is not specific to cortisone, as we have measured a fall after the intravenous administration of both ascorbic acid and glutathione. In fact, the effect of 1 gm. ascorbic acid given by this route may be observed leaving the needle *in situ*, since it is apparent within two minutes of the injection. Our experiences with indicator dyes, together with the observations of Long *et al.*[2] on the effect of cortisone and ascorbic acid on tuberculin sensitivity in guinea pigs, had originally led us to expect that cortisone, by shifting the ascorbic ⇌ dehydroascorbic acid equilibrium in the tissues to the right, would produce a rise in tissue electrode potential. In fact, a fall has been found uniformly to occur. This is in harmony with the work of Stewart *et al.*[3], who have shown that 20 per cent of the plasma ascorbic acid is normally in the dehydro form and that cortisone causes the temporary disappearance of this oxidized fraction without altering the total level. This shift of the equilibrium to the left is consonant with a fall in electrode potential as found in our experiments, and occurred at the same time after oral administration of the drug.

We wish to thank Dr. George Brownlee for advice and criticism; the Cambridge Instrument Co., Ltd., for making the needle electrode to our instructions; the Medical Research Council and Ciba (Basle) for supplies of cortisone and control material; and British Drug Houses, Ltd., for the glutathione.

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Sept. 22.

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Diabetogenic Effect of Nucleic Acid

The discovery of alloxan diabetes was followed by an examination of the specificity of alloxan. Whether alloxan could be found in biological material and its possible function in the intermediary metabolism were also investigated.

The effect of substances natural to the organism obviously attracted attention. Griffiths[1] found that chronic hyperglycæmia in rabbits could be induced by sufficient doses of uric acid, provided the rabbits lived on a diet lacking cysteine and methionine for a long period. He found that a dose of 1 gm. of uric acid to 1 kgm. body-weight was sufficient. The investigations of J. W. Patterson[2] on the diabetogenic effect of dehydroascorbic and dehydro*iso*ascorbic acids are also of importance.

Nucleic acids as a group are related to uric acid. We have examined whether nucleic acids could have diabetogenic effects under certain conditions.

Ribonucleic acid (Natrium nucleinicum e faece Merck), 1 gm. to 1 kgm. body-weight, dissolved in water was injected intraperitoneally into three rabbits starved for 48 hr. The curve of blood sugar immediately after the injection of nucleic acid was followed by the determination of glucose by Hagedorn–Jensen's method. Then for ten days the urine was collected from metabolic cages and we determined glycosuria at intervals of 24 hr.

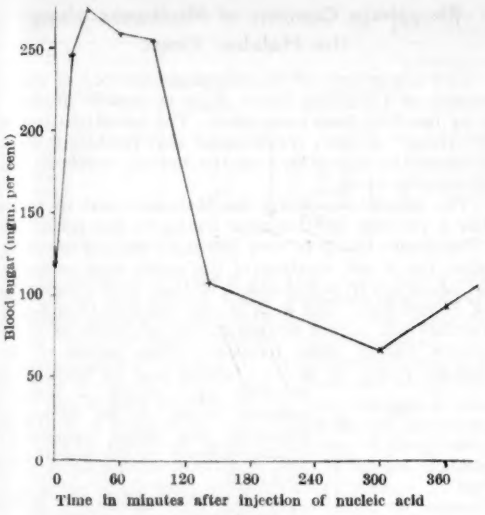

Fig. 1

Nucleic acid was injected in the same doses as in the previous experiment to a group of rats starved for 24 hr. Then the rats were killed at different intervals (30 min., 45 min., 90 min., and 300 min.) after the injection. Immediately after death, we removed some of their organs and determined quantitatively the reduced glutathione in them, employing the modified Kühnau method. Results from this experiment, reproduced in Fig. 2, have been arrived at statistically.

The intraperitoneal injections cause hyperglycæmia in rabbits; later, hyperglycæmia changes into hypoglycæmia, and finally the blood sugar content remains at the level of about 200 mgm. per cent (Fig. 1). Then the rabbits show slight glycosuria for a few days.

If animals which have lived on a diet lacking cysteine and methionine for several days are used, the symptoms of diabetes are much stronger.

The curve of the contents of reduced glutathione in the livers, pancreas and adrenals is shown in Fig. 2. The courses of the curves are identical with those observed after the injection of alloxan[3].

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Brno. Aug. 30.

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[2] Patterson, J. W., *J. Biol. Chem.*, **183**, 81 (1950).
[3] Brada, Z., *Arch. Int. Pharmacodyn.*, **85**, 497 (1951).

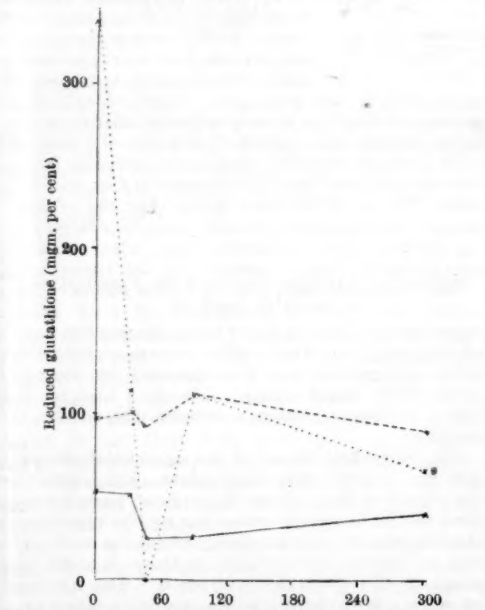

Fig. 2

———, Liver; ....., adrenals; ———, pancreas

Seasonal Variation in the Plankton and Salinity of the Hauraki Gulf, New Zealand

The seasonal variation of the plankton of the Hauraki Gulf, New Zealand, has not previously been studied. From November 1948 until October 1950, a pilot survey of the plankton of the Gulf was made possible by the courtesy of the Marine Department of the Government of New Zealand, which made available its research vessel *Ikatere*.

It is found that there is an inner coastal population of fairly constant composition, characterized by *Corycæus aucklandicus* Krämer, and containing also *Temora turbinata* Dana, *Acartia clausii* Giesbrecht and *Euterpina acutifrons* (Dana), all of which are quite common. In summer months only, *Penilia avirostris* Dana[1], *Podon polyphemoides* Leuchart and *Evadne* species are also found in quantity in the coastal population.

The outer region of the Gulf contains an oceanic population which varies according to the season. From November 1948 to April 1949, from October 1949 to May 1950, and in October 1950, the outer region of the Gulf was dominated by salps. These were chiefly *Thalia democratica* (Forskål), but *Salpa fusiformis* Cuvier and *S. cylindrica* Cuvier were also common on occasion. Associated with the salps were the copepods *Rhincalanus cornutus* Dana and *Sapphirina* species, and also stomatopod larvæ.

In the winter months, particularly July, of 1949 and 1950, the oceanic region of the Gulf was dominated by chætognaths, notably *Sagitta planctonis* Steinhaus, *S. serratodentata* Krohn and *S. hexaptera* d'Orbigny. With these the copepod *Oncæa venusta* Philippi was frequently taken.

During July and August 1949, and in July 1950, salps were not recorded at all in the Gulf. In August 1950, they were very infrequent. In view of the known life-history of salps, it is clear that the body of water containing salps in summer cannot be the same as the body of water containing chætognaths in winter. Two other possibilities exist. Either there is a constant invasion of oceanic water from the same source, bearing salps in summer and sagittas in winter; or two distinct oceanic waters invade the Gulf alternately, in summer a salp-bearing water from one source and in winter a sagitta-bearing water from another source.

It is not possible to correlate the occurrence of salps with temperature. Each year salps reappeared in the coldest months—August or September—with

a water temperature of 13°–14° C. They persisted through the summer with maximal temperatures of 22° C., and then disappeared in July when the temperature had dropped to 15° C.

In the second year of the survey, salinity observations were made to discover whether the seasonal changes in plankton could be correlated with changes in salinity. It was found that the average salinity of the Gulf rises from 35·30 parts per thousand in November, when salps are dominant, to 35·70 in July, when salps are absent. Salinity then declines to 35·50 parts per thousand in August, when salps are found infrequently, and then to 35·40 in October, when salps are dominant. It will be noted that salps reappear when salinity begins to decrease. Conversely, chætognaths are almost entirely restricted to the months April–August, when salinities are above 35·50.

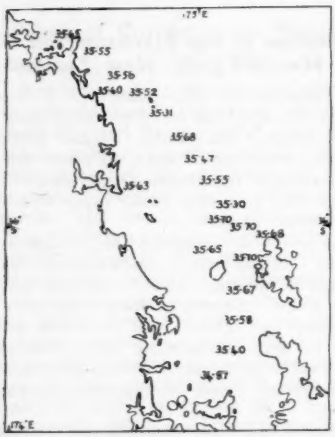

Fig. 1. Salinity (parts per thousand) of the Hauraki Gulf and more northern waters in July 1950

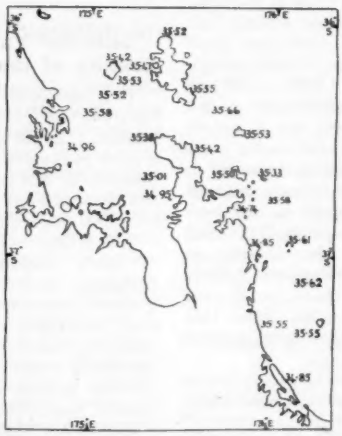

Fig. 2. Salinity (parts per thousand) of the Hauraki Gulf and more eastern waters in August 1950

When the salinity of the Gulf is rising, the water of high salinity apparently comes from the north. In July, the bulk of the water in the Gulf is of salinity 35·60–35·70, but there is an outer area of salinity about 35·50 (Fig. 1). In August the Gulf appears to have been diluted from its outer limits inwards (Fig. 2).

These results, by themselves, are not incompatible with either type of oceanic influx suggested above. It is believed, however, that the Notonectian Current from the Tasman Sea varies in its flow around the North Cape of New Zealand, being greatest in summer and least in winter[2]. So it appears possible that the seasonal variation of plankton and salinity described above may be associated with variation in the flow of this current; but this is, of course, not proved.

The observations on which this report is based were made when I was a temporary lecturer at Auckland University College. I am indebted to Prof. W. R. McGregor and the Council of that College for extending the tenure of my appointment so that the survey could be operated over two years.

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Sept. 17.

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Phosphate Content of Mudbanks along the Malabar Coast

The importance of the phosphate content of water masses as a limiting factor in their organic productivity has long been recognized. The investigations of Mortimer[1], Moore[2], Stephenson[3] and Rochford[4] have stressed the importance of the bottom muds in the phosphate cycle.

The inshore sea along the Malabar coast of India has a peculiar environment owing to the formation of extensive banks of very fine mud settling regularly after the rough weather of the south-west monsoon which occurs from the month of June to the beginning of September. The area is also subject to a heavy rainfall (121 in. per annum at Calicut) most of which occurs during these months. This region of the Indian coast is highly productive in respect of fisheries and shows a marked seasonal cycle in its biological features, this being apparently closely related to the south-west monsoon.

In connexion with the study of the fishery and ecology of the inshore area near Calicut, it was considered useful to study the composition of the material forming these mudbanks and to follow the seasonal changes, especially in its phosphate content in relation to the phosphate content of the overlying water and to the seasonal changes in the biology of the area. In view of recent trends in such phosphate studies, it was particularly suggested to me by Dr. N. K. Panikkar that the west coast mudbanks probably form reservoirs of inorganic nutriment playing an important part in the annual cycle, and that their detailed investigation is necessary to understand the fisheries cycles. Work on these lines is in progress, and it is already apparent that these mudbanks contain considerable quantities of phosphates (even if we take only the interstitial inorganic fraction into account) and that the results confirm the above view. The work has also shown that the release of phosphates from the mudbanks takes place largely during the south-west monsoon period, when the waters are continually highly agitated by the strong winds.

The accompanying table shows the values of interstitial and adsorbed phosphates of mud samples taken at two stations near Calicut during the months of January–June 1952. The procedure followed in these estimations was that detailed by Rochford[4] with slight modifications. The mud samples were taken by means of a grab sampler instead of a core sampler.

The individual values of the interstitial phosphate (per gm. of mud) were themselves often higher than the corresponding values of inorganic phosphate (per litre) in the overlying water during the pre-monsoon months, and per unit weight or volume the mud may be said to contain several hundred times as much phosphate as the water-layer above it. The interstitial phosphate is released into the water by agitation. A severe agitation of the sea bottom, noticed during the south-west monsoon of 1950, resulted in a large increase in the phosphate content of the water. During

INTERSTITIAL PHOSPHATE AS PHOSPHATE PHOSPHORUS IN PARTS PER MILLION OF DRY MUD AND ADSORBED PHOSPHATE SIMILARLY IN DRY SILT FROM MUD SAMPLES NEAR CALICUT

Months	Samples per station	Station I (4 m.)				Station II (19 m.)			
		Interstitial		Adsorbed		Interstitial		Adsorbed	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
January	5	13 to 35	26	19 to 80	47	21 to 27	25	18 to 68	33
February	4	22 to 43	35	9 to 41	21	25 to 33	29	9 to 22	16
March	3	19 to 27	23	13 to 43	25	17 to 25	20	16 to 39	24
April	4	11 to 25	17	17 to 28	24	12 to 19	15	9 to 33	18
May	3	13 to 19	15	20 to 35	27	24 to 46	33	12 to 17	14
June	2	7 to 20	13	22 to 25	23	9	9	4 to 16	10

the pre-monsoon months in 1952 again, the phosphate content of the inshore water was very low, but it increased after the commencement of the monsoon rough weather that disturbed the mudbanks. It appears highly probable that the well-marked seasonal features in the biology of the inshore area along this coast are closely related among other factors to the existence of these extensive mudbanks, the retention by them of relatively large quantities of phosphates (and perhaps other nutrients) and the release of these during the south-west monsoon every year.

The mudbanks have also been found to contain fairly high quantities of adsorbed phosphate. The material of these mudbanks is derived partly from the laterite formation which fringes this coast[5]. An analysis of a sample of laterite has revealed a high 'adsorbed' phosphate content, and since a considerable quantity of laterite silt is washed into the sea during the rainy seasons, this seems to be a constant source to supplement the local turnover of phosphates in the inshore area.

I wish to thank Dr. N. K. Panikkar, Dr. W. R. G. Atkins and Dr. B. S. Bhimachar for helpful criticism.

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Occurrence of *Puccinia polysora* Underw. in East Africa

Rhind, Waterston and Deighton reported epidemics of *Puccinia polysora* Underw. in West Africa in 1949 and the following years[1]. Fears were expressed that this disease might eventually reach East Africa. Plans were accordingly made for authorities in West Africa to test East African varieties of maize for susceptibility to the fungus, and for the introduction of maize varieties from Central America in the hope that resistant types might be found in an area where the disease is endemic.

The maize rust hitherto recorded in East Africa and generally present throughout the Territories is *Puccinia sorghi* Schw. In June 1952, outbreaks of maize rust, exceeding in severity any previous occurrence, appeared in the Coast Province of Kenya. Collections, which comprised the uredo and teleuto stages, were examined by Dr. G. R. Bisby[2], who stated that the teleuto stage agreed exactly with the original American collections, thus affording final confirmation of an identification which remained uncertain so long as the uredo spores alone were available. This is believed to be the first record of the teleuto stage of *P. polysora* outside America.

Subsequent collections of uredo material were examined from Zanzibar and milder attacks from Uganda and Tanganyika, where both species of rust were found occupying the same leaf. All collections from the Kenya Highland have, so far, been *P. sorghi*; and, in fact, all records of severe attacks of *P. polysora* have been from the warmer, more humid areas. It is hoped that the Kenya Highlands, where maize is the most important food crop of the native population, may remain free.

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[1] Rhind, J., Waterston, J. M., and Deighton, F. C., *Nature*, **169**, 631 (1952).
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Cerastium arcticum Lange

RECENT publications containing references to this plant have used the name *C. edmondstonii* (Wats.) Murb. and Ost.[1] in preference to the older name *C. arcticum* Lange[2]. The objection to using the older name is, according to Hylander[3], that "there is no authentic, i.e. chosen by Lange, type specimen". But this in itself is no reason for dismissing the older name since the description is validly published. Moreover, Murbeck and Osterfeld in their description[1] only redescribed Lange's plant. They also took the varietal epithet, var. *edmondstonii*, and gave it specific rank. This is in contradiction to the rules of botanical nomenclature, and therefore the name *C. edmondstonii* is illegitimate.

Recent work on the cytology of this species, using material collected from Snowdon in Wales and Ben Nevis in Scotland, has shown that the chromosome number is $2n = 108$ (Fig. 1). Some seedlings, however, gave higher chromosome numbers, and it is suspected that occasionally this species may be cross-pollinated by *C. holosteoides* Fries (*C. vulgatum* L.), $2n = 144$, which grows in the vicinity. One plant, from Snowdon, showed a highly irregular meiosis with many lagging chromosomes at both first and second anaphase, and it is thought that this may have been a hybrid, although it closely resembled *C. arcticum*. Pollen-mother cells from other plants showed a perfectly regular meiosis with $n = 54$. At first metaphase many multivalents can be seen (Fig. 2), usually in the centre of the cell with the bivalents arranged in a ring outside them. A very similar arrangement has been seen in *C. holosteoides*.

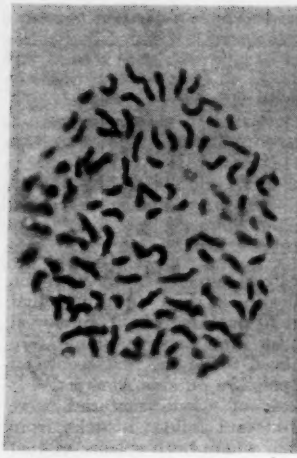

Fig. 1. Root-tip metaphase in *Cerastium arcticum* Lange with 108 chromosomes. × 2,000

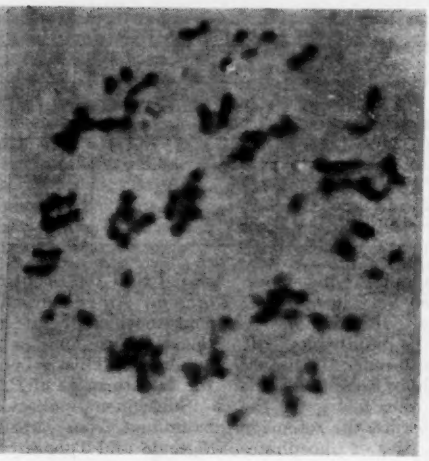

Fig. 2. First metaphase in a pollen mother cell of *Cerastium arcticum* Lange showing many multivalents. × 2,000

Chromosome counts for all the British species of *Cerastium* have now been made. Unpublished counts besides *C. arcticum* $2n = 108$ are *C. cerastoides* (L.) Britton $2n = 38$ and *C. pumilum* Curt. $2n = 90$ and $2n = 95$. The count for *C. cerastoides*, which was also collected on Ben Nevis, agrees with counts made by other workers for material collected in the Alps[4] and in Greenland[5]. The *C. pumilum* material, $2n = 90$, which was collected in Surrey, agrees with the count made by Söllner[6] for Swiss material. In the Surrey material, the higher number $2n = 95$ was more common than $2n = 90$.

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[3] "Flora Danica", **17**, Fasc. 50, 7 (1883).
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A Method of obtaining Phloem Sap via the Mouth-parts of Aphids

Although aphids and coccids are known as 'sucking' insects, suggestions have been made from time to time[1] that forces within the plant, set up by or even independent of the insect, assisted in the feeding process. Yust and Fulton[2] observed fluid exuding from broken-off mouth-parts left embedded in lemons after detachment of the coccids which had been feeding there. The exudate formed pools on the lemon skins from which samples were taken for sugar analyses. When experiments on the feeding preferences of *Aphis fabæ* Scopoli[3] were extended to the comparison of turgid and wilting leaves on otherwise similar plants, the wilting leaves proved to be less acceptable to the aphids. The inference that aphids depend less on their own sucking power than on the turgor pressure in the plant tissue, to maintain the flow of plant sap through the exceedingly fine food canal within their maxillary stylets, was checked by severing the mouth-parts of *A. fabæ* individuals feeding on beans. Here, too, fluid was observed to exude from the stylet stumps left projecting from the plant surface.

The technique of obtaining sap from severed aphid stylets has been developed since (by T. E. M.) using the lachnid, *Tuberolachnus salignus* (Gmelin), a conveniently large species colonizing the branches of *Salix* spp. That part of the aphid's rostrum which remains outside the plant during feeding can be severed by a clean cut down on to the bark, without dislodging the stylet tips from their normal situation inside a phloem sieve-tube. The operation can be done on living insects on intact growing plants. The exuding sap can be collected continuously by sleeving the projecting stylet stump in the end of a capillary tube. Exudate has been collected in this way at the rate of about 1 cu. mm. per hour uninterruptedly for periods of up to four days. Very similar rates of honey-dew excretion were recorded from adjacent intact aphids, suggesting that the force responsible for moving the sap out of the plant into the normally feeding insect is provided almost entirely by the pressure in the phloem sieve-tubes themselves. The chemical evidence confirms the view that the stylet exudate is the same as the sap ingested by aphids.

This method of obtaining phloem sap is now in routine use in a study of aphid nutrition, and might also be of use to plant physiologists. It is possible that stylet exudate differs somewhat from sieve-tube sap in an aphid-free plant. But the resemblance should be closer than that of extracts of whole phloem tissue, on which past studies of translocation, for example, have so largely been based.

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Sept. 26.

[1] Zweigelt, F., *Zbl. Bakt.*, Abt. 2, **42**, 265 (1914). Leonhardt, H., *Z. angew. Ent.*, **27**, 208 (1940).
[2] Yust, H. R., and Fulton, R. A., *J. Econ. Ent.*, **34**, 307 (1943).
[3] Kennedy, J. S., and Booth, C. O., *Ann. App. Biol.*, **38**, 25 (1951).

Shell Regeneration in some British Molluscs

A study of shell regeneration in *Helix aspersa* (Müller)[1] showed that this snail was able to repair its shell with rapidity, chiefly by virtue of the speed with which amœbocytes could transport materials to the damaged area, either from the digestive gland or from other parts of the shell. It was of considerable interest, therefore, to investigate whether a similar process could operate in other Mollusca, and particu-

larly whether there was any distinction between snails in different habitats.

As a result of investigations on a limited number of species, carried out along the same lines as those used for *Helix aspersa*[1], it was established that the following land snails could regenerate their shell as readily as could *Helix aspersa* :

Helicidæ

Helicella itala (L.)
Helicella caperata (Montaqu)
Cochicella acuta (Müller)
Monacha cantiana (Montaqu)
Monacha cartusiana (Müller)
Hygromia striolata (Pfeiffer)
Hygromia subrufenzis (Müller)
Hygromia hispida (L.)
Helix hortensis (Müller)
Helix nemoralis (L.)
Helix pomatia (L.)
Arianta arbustorum (L.)

Clausiliidæ

Balea perversa (L.)
Clausilia rugosa (Draparnaud)
Marpessa laminata (Montaqu)

Succineidæ

Succinea elegans (Risso)
Succinea putris (L.)

It was of interest that the largest land snail, *Achatina fulica* (Ferssac.), was also able to regenerate its shell.

These terrestrial gastropods similarly stored calcium products within protein spheres in the digestive gland. Removal of pieces of shell in all these species stimulated amœbocytes to withdraw materials from these stores for the repair of the shell. Other amœbocytes, under such conditions, were demonstrated withdrawing calcium carbonate and proteins from small pieces of original shell placed over the damaged area. Possibly all land Pulmonates are similarly able to repair damage to the shell. Certainly any land snail (unless living continuously in a very humid atmosphere) would need to be able to protect its delicate internal organs efficiently to prevent desiccation.

This regenerative ability is not shared by the Prosobranch *Pomatia elegans* (Müller). Similarly, intertidal Prosobranchs do not cover over damaged shell areas as do the Pulmonates during experimental periods of four weeks. Yet, by contrast, those land Pulmonates that were investigated protected a damaged area of 1 sq. cm. within three hours and continued to thicken the regenerating tissues for at least another forty-eight hours.

Shell repair in land Pulmonates is a process comparable with shell thickening, both involving calcification of successive organic membranes. In those intertidal and marine species examined there was a failure to secrete an initial organic membrane over the damaged area. If this is artificially introduced, in the form, for example, of a glass coverslip[2], then repair is possible, although more slowly than in the land Pulmonates. The marine Mollusca that were examined and were unable to regenerate their shell, in the absence of an artificial covering, within a period of four weeks were :

Prosobranchia

Haliotis tuberculata (L.)
Emarginella reticulata mülleri (Forbes and Hanley)
Diodora apertura (Montaqu)
Patella vulgata (L.)
Patella depressa (Pennant)
Patina pellucida (L.)
Patina lævis (Pennant)
Calliostoma zizyphinum conuloide (Lamarck)
Gibbula cineraria (L.)
Gibbula umbilicalis (da Costa)
Gibbula magnus tuberculata (da Costa)
Osilinus lineatus (da Costa)
Lacuna parva (da Costa)
Littorina saxatilis rudis (Maton)
Littorina saxatilis saxatilis (Olivi)
Littorina rudis (Maton)
Littorina littorea (L.)
Neritoides littoralis (L.)
Turitella communis (Risso)
Crepidila fornicata (L.)
Natica catona (da Costa)
Natica montagui (Forbes)
Lamellaria latens (Müller)
Trivia monacha (da Costa)
Nucella lapillus (L.)
Ocenebra erinacea (L.)
Buccinum undatum undatum (L.)
Hima reticulatus (L.)

Opisthobranchia

Acteon tornatilis (L.)
Tricla punctostriata (Mighels and Adams)
Aplysia punctata (Cuvier)

Lamellibranchiata

Anomia ephippium (L.)
Mytilus edulis (L.)
Chlamys varia (L.)
Cardium edule edule (L.)
Cardium aculeatum (L.)
Venus verrucosa (L.)

The freshwater species *Viviparus viviparus* (L.) has been shown by Heaysman[3] to repair its shell, though rather irregularly and not with the same speed as *Helix aspersa*.

Bevelander[4] and Heaysman[3] have both established that the marine and freshwater species that they examined could absorb calcium directly from their environment. Neither the freshwater nor the marine species are subjected to the possibility of desiccation and, provided their body fluids are isotonic with the water in which they are living, damage to the shell need not be serious to the animal. Spherules containing calcium were not found in the digestive gland of the marine species that were studied. Again, surrounded with a constant supply, the need for the accumulation of calcium reserves is much less important here than for the land molluscs that are usually entirely dependent on very low concentrations of calcium from their foods. Those that live on calcareous soils have a richer calcium supply and consequently have thicker shells.

The amœbocytes that carry the necessary materials for shell repair and shell thickening play a vital part in the preservation of land snails, since damage to the shell under natural conditions is fairly common, judged by the numbers of snails that are found in the wild with repaired shells. Probably, as Heaysman suggests[3], these same amœbocytes play only a minor part in the formation of new shell, since shell-growth and shell-repair are quite different processes, the former associated with the growth of the whole animal, the latter with 'first aid' to an injury. Land Pulmonates may well owe their ability to live away from water to the speed with which these amœbocytes can work, particularly when it is found that none of the land Pulmonates examined failed to produce large numbers of these amœbocytes when they were required.

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Oct. 10.

[1] Wagge, L. E., *Quart. J. Mic. Sci.*, **92**, 307 (1951).
[2] Bevelander, G., and Benzer, P., *Biol. Bull.*, **94**, 176 (1948).
[3] Heaysman, J. E. M., Ph.D. thesis, University of London (1951).
[4] Bevelander, G., *Biol. Bull.*, **102**, 9 (1952).

Detection of Phosphate Esters on Paper Chromatograms

Phosphate esters separated on paper chromatograms are usually detected by degrading them on the paper with acid to give *ortho*-phosphoric acid and detecting this by the reaction with molybdate and a reducing reagent. The procedure of Hanes and Isherwood[1] is based upon this and is widely used. This technique suffers from two disadvantages. In the first place, the prolonged initial 'digestion' necessary to break down the more resistant esters frequently leaves the paper in a very fragile state ; and secondly, further analyses cannot be carried out on the spot after treatment. In order to avoid these disadvantages the following technique was developed. It depends upon the fixation of ferric ions by the esters and the reaction of the free ferric ion with salicylsulphonic acid. If the paper is not strongly buffered it is sprayed

with 0·1 per cent $FeCl_3.6H_2O$ in 80 per cent alcohol, dried in air at room temperature and then sprayed with 1 per cent salicylsulphonic acid in 80 per cent alcohol. Upon drying, the phosphates appear as white spots on a pale mauve background, *ortho*-phosphate having a band of deeper mauve surrounding it. The colour formation occurs only when the *p*H of the residual moisture in the paper is about 1·5–2·5. This can be checked conveniently with thymol blue, since the colour formation occurs most satisfactorily when the paper just turns this indicator red. Further indications of unsatisfactory *p*H are that below this range no colour is formed, whereas above the range the colour is orange-yellow and definition of the spots is very poor.

When the chromatogram is heavily buffered, modifications to the above reagents are necessary. For example, when there is strong buffering on the alkaline side, it may be necessary to increase the concentration of salicylsulphonic acid to about 10 per cent; when buffering occurs at a low *p*H, the sodium salt may be used.

Other spot indicators of ferric ions have also given good results; but they were either nitrogenous compounds that would interfere with nitrogen determinations or gave colours that faded in light.

Before elution of the chromatogram spots a permanent record of the chromatogram can be made by taking a contact print on a document printing paper such as Ilford No. 50. The colour lends itself well to this, and prints can be obtained that give even better definition of the spots than the original chromatogram.

If a sufficient quantity of ester is present, it can be located on the paper before spraying with salicylsulphonic acid by observing the paper in transmitted daylight or ultra-violet light from a low-pressure mercury lamp incorporating a Wood's filter.

The technique described permits the detection of 1–2 μgm. phosphorus, as phosphate ester, distributed over an area of about 1 sq. cm. The treatment is sufficiently mild not to cause any significant breakdown of adenosine triphosphate providing elution is carried out on the same day as the spraying.

We wish to record our thanks to Major L. H. Kent for his advice and interest. Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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[1] Hanes, C. S., and Isherwood, F. A., *Nature*, **164**, 1107 (1949).

Vesicular Laterite

The suggestion has been made that the vesicular form of lateritic ironstone owes its characteristic sponge-like structure to termite action, presumably to burrowing by these insects before the material hardened[1].

It is possible that termite action may be responsible in some instances for the perforations; but evidence from the Aripo Savannah in Trinidad (which botanically interesting area receives special mention in Charles Kingsley's "At Last") indicates that vesicles may be a normal morphological feature. The soil profile on this savanna consists of a grey sandy upper layer of about a foot to eighteen inches depth, grading into a material with the consistency of 'Plasticine' with pronounced reddish-yellow mottling. During the wet season, May–December, the water-table lies at or near the surface of the ground, while during the dry season, January–April, it may recede six or more feet. The site is a level one and conditions are correct for the development of a 'ground-water laterite'.

By a fortunate chance during the Second World War, roads were made through this area for military purposes. The area is unfit for agriculture, and had it not been for this chance the present observations might not have been so readily made.

Making of the roads, or more correctly the making of drains at the road-sides, has resulted in the exposure of the mottled horizon. The result, which could scarcely have been predicted by mere inspection of the undisturbed profile, is that 'ironstone' fragments, ranging through all degrees of hardness to completely indurated, have been isolated and stand out on short columns of softer material. They range in size from grain size to more than six inches in length. The larger fragments have the grotesque shapes characteristic of the 'fossil' laterite of Uganda and elsewhere, and which in this case are determined by the irregular shapes of the mottles from which they have been formed. Some of the fragments show smooth-sided perforations, the contents of which have been washed out by rain. The accompanying photograph illustrates one such fragment.

It is suggested that the undisturbed profile represents a stage preceding that which, by progressive enlargement and ultimate contact and fusion of the mottles, would furnish on induration and removal of the softer enclosed material a more or less continuous pavement of vesicular ironstone.

A mound-building termite does occur in the area (*Nasutitermes ephratæ*)[2]; but its mounds are infrequent in occurrence and small in size (less than 2 ft. high with a base of about 1½ ft.) There was no sign of termite burrows in the pits examined, and termite action may be excluded in this case as in any way contributing to the whorls and perforations of the indurated material.

The profile will now be studied critically, with the view of tracing the stages of induration, etc., and the findings will be published in due course.

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Sept. 15.

[1] Russell, E. J., "Soil Conditions and Plant Growth", 508, 8th edit. (Longmans, Green and Co., London).
[2] Adamson, A. M., *Trop. Agric.*, **17**, 12 (1940).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 23

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (in the Main Chemical Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 4 p.m.—Prof. V. Prelog (Zürich): "Organic Chemistry". (Further Lectures on March 24 and 27.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Dr. G. P. Wibberley: "Some Aspects of Problem Rural Areas in Great Britain".

INSTITUTE OF METALS (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Sir Christopher Hinton: "The Present and Future Requirements of the Chemical Engineer" (Annual May Lecture).

Tuesday, March 24

CHADWICK PUBLIC LECTURE (in the Lecture Hall, Chadwick Department of Civil and Municipal Engineering, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. H. R. Oakley: "Public Health Engineering—Research and Training".*

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. J. B. Matthews, Mr. J. H. T. Brook, Mr. H. C. Evans, Mr. J. Hughes and Dr. R. P. Taylor: Papers on "The Examination of Used Lubricating Oils".

ROYAL SOCIETY OF MEDICINE, MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Discussion on "The Chemotherapy of the Reticuloses".

Tuesday, March 24—Thursday, March 26

INSTITUTE OF METALS (at the Park Lane Hotel, Piccadilly, London, W.1).—Annual General Meeting.

Tuesday, March 24

Presidential Address.

Wednesday, March 25

Symposium on "Control of Quality in the Production of Wrought Non-Ferrous Metals".

Wednesday, March 25

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Peter Opie: "The Collection of Folklore in England".

PHYSICAL SOCIETY, COLOUR GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3.15 p.m.—Annual General Meeting; at 3.30 p.m.—Dr. T. Vickerstaff: "Colour Problems in the Dyeing Industry" (Chairman's Address).

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Miss M. S. Rix: "Construction of an Index Number of Gilt-Edged Values".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Gertrude Williamson: "Population Problems and Family Policy in France".*

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Mr. N. W. Pirie, F.R.S., and Dr. A. C. Thaysen: "Newer Sources of Foodstuffs" (Food and the Future, 3).

Wednesday, March 25—Friday, March 27

INSTITUTION OF NAVAL ARCHITECTS (on board the *Wellington*, Headquarters Ship of the Honourable Company of Master Mariners, Temple Stairs, Victoria Embankment, London, W.C.2), at 10.15 a.m. each day.—Spring Meeting.

INSTITUTE OF PHYSICS (at Bedford College, Regent's Park, London, N.W.1).—Conference on "Static Electrification".

Thursday, March 26

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. S. Biobaku: "Egba Traditional Authorities".

Thursday, March 26—Friday, March 27

FARADAY SOCIETY, COLLOID AND BIOPHYSICS COMMITTEE (in the Wheatstone Physics Laboratory, King's College, Strand, London, W.C.2).—Discussion on "The Nature and Structure of Collagen".

Friday, March 27

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (joint meeting with the MANCHESTER SECTION of the S.C.I., and the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, The University, Manchester), at 10.30 a.m.—Symposium on "Corrosion Inhibitors".

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 11 a.m.—Annual General Meeting; Scientific Papers.

ROYAL SCOTTISH FORESTRY SOCIETY (in the Large Lecture Hall, Royal Botanic Garden, Inverleith Row, Edinburgh), at 2 p.m.—100th Annual Business Meeting.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "Magmatic Diffusion and the Hot Hydrosphere".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Eric Rideal, F.R.S.: "Count Rumford and the Royal Institution".

ROYAL AERONAUTICAL SOCIETY (in the Chemistry Lecture Theatre, University College, Gower Street, London, W.C.1).—Discussion on "Fatigue".

Friday, March 27—Saturday, March 28

BRITISH PHARMACOLOGICAL SOCIETY (joint meeting with the FINE CHEMICALS GROUP of the SOCIETY OF CHEMICAL INDUSTRY, at the Wellcome Research Institution, 193 Euston Road, London, N.W.1), at 9.30 a.m. and 2.30 p.m. each day.—Symposium on "Anticholinesterases".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICER (preferably with experience in biological and/or physical chemistry) IN THE BACTERIOLOGY DEPARTMENT—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (March 28).

LECTURER IN HUMAN PHYSIOLOGY, and a LECTURER IN EXPERIMENTAL (Mammalian) PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (March 28).

SCIENTIFIC OFFICERS AT THE NATIONAL AERONAUTICAL ESTABLISHMENT, Bedford, to plan and conduct tests in supersonic wind tunnels and to interpret results—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.117/53A (March 28).

ASSISTANT ADVISER (with a degree or the national diploma in horticulture) IN HORTICULTURE—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (March 31).

ASSISTANT LECTURER (probationary) IN METALLURGY—The Registrar, University College, Singleton Park, Swansea (March 31).

SENIOR RESEARCH STUDENTSHIP IN METALLURGY, and a probationary ASSISTANT LECTURESHIP IN METALLURGY—The Registrar, University College, Singleton Park, Swansea (March 31).

EXPERIMENTAL OFFICER (Grade III) AT THE AERONAUTICAL RESEARCH LABORATORIES, Fishermen's Bend, Melbourne, to carry out wind tunnel investigations related to the development of new aircraft types—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1, quoting No. 248 (April 2).

RESEARCH ASSISTANT (Grade II) IN THE DEPARTMENT OF TEXTILES, Victoria and Albert Museum—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 237/53 (April 2).

LECTURER (Grade II) IN MINING (Coal), and a RESEARCH FELLOW IN COAL TREATMENT—The Registrar, The University, Edgbaston, Birmingham 15 (April 4).

RESEARCH OFFICER TO THE PHYSICAL CHEMISTRY SECTION, Division of Industrial Chemistry, Fishermen's Bend, Melbourne, to investigate the properties of solutions of polyelectrolytes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 4173 (April 4).

LECTURER and an ASSISTANT LECTURER IN (*a*) GAS ENGINEERING AND (*b*) FUEL TECHNOLOGY—The Registrar, The University, Leeds 2 (April 6).

LECTURER (Grade III or II, preferably with interests in pure mathematics) IN MATHEMATICS—The Registrar, The University, Bristol 8 (April 7).

ASSISTANT LECTURER (graduate with qualifications and/or experience in heavy electrical engineering) IN ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (April 10).

ASSISTANT LECTURER IN MATHEMATICS (preferably with special qualifications in algebra or geometry)—The Registrar, Queen Mary College, Mile End Road, London, E.1 (April 10).

CHIEF CHEMIST (with honours degree in chemistry, and with experience in inorganic analysis) IN THE GEOLOGICAL SURVEY, Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (April 10).

SENIOR LECTURER-IN-CHARGE IN THE DEPARTMENT OF MINING, University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 10).

LECTURER OR ASSISTANT LECTURER IN MATHEMATICS at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 11).

RESEARCH CHEMIST to take charge of the Regional Chemical Laboratory of the Division of Soils of the Commonwealth Scientific and Industrial Research Organization, at Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 270/83 (April 11).

RESEARCH OFFICER TO THE MINERALS UTILIZATION SECTION, Division of Industrial Chemistry, Fishermen's Bend, Melbourne, to undertake research work in the field of inorganic and physical chemistry—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 4187 (April 11).

SCIENTIFIC OFFICER (with honours degree in botany) for potato breeding with special reference to breeding for resistance to potato root eelworm—The Secretary, Scottish Plant Breeding Station, Craigs House, Corstorphine, Edinburgh 12 (April 11).

SCIENTIST (Grade III) (with a good honours degree in geology or chemistry, and some experience or special interest in preparing scientific papers and reports) on the Coal Survey headquarters in London, mainly to assist in the preparation and editing of Coal Survey publications—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/606 (April 11).

SENIOR RESEARCH OFFICER (Theoretical Physicist) IN THE DIVISION OF ELECTROTECHNOLOGY, National Standards Laboratory, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 4078 (April 11).

EXCHANGE FELLOWSHIPS IN CANCER RESEARCH offered by the National Cancer Institute of Canada and the American Cancer Society—The Secretary-General, British Empire Cancer Campaign, 11 Grosvenor Crescent, London, S.W.1, endorsed 'Exchange Fellowship' (April 12).

ENGINEERS or CHEMICAL ENGINEERS (Senior Lecturers or Lecturers) with wide practical experience of food processing operations, for example, canning, dehydration—The Registrar, National College of Food Technology, Cranwood Street, London, E.C.1 (April 15).

LECTURER IN PHYSIOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 15).

RESEARCH FELLOWSHIPS IN GOVERNMENT SCIENTIFIC ESTABLISHMENTS for research into subjects of importance to H.M. Government—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4192/53 (April 15).

ASSISTANT LECTURER (with honours degree in chemistry, and research experience) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Bedford College, Regent's Park, London, N.W.1 (April 17).

RAMSAY MEMORIAL FELLOWSHIPS FOR ADVANCED STUDENTS OF CHEMISTRY—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 17).

I.C.I. RESEARCH FELLOWSHIPS IN CHEMISTRY, PHYSICS and allied subjects, including the biological application of chemistry—The Registrar, University Office, 46 North Bailey, Durham (April 18).

LECTURER IN CHEMICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (April 18).

SCIENTIST (Grade II), a SCIENTIST (Grade III) or SCIENTIFIC TECHNICAL OFFICER (Grade I) on the staff of the Director of Scientific Control, to carry out environmental studies at collieries in connexion with a long-term Field Research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/6C.7 (April 18).

UNDERGRADUATE SCHOLARSHIPS, POST-GRADUATE SCHOLARSHIPS, and RESEARCH FELLOWSHIPS FOR UNIVERSITY STUDY IN MECHANICAL ENGINEERING, TEXTILE ENGINEERING, TEXTILE TECHNOLOGY and certain allied subjects—The Secretary, Sir Walter Preston Scholarship Trust, Textile Machinery Makers, Ltd., 60 Huddersfield Road, Oldham (April 18).

ASSISTANT LECTURERS IN BOTANY, with special interests in either plant ecology and/or plant morphology, or mycology and/or microbiology—The Principal, Royal Holloway College, Englefield Green, Surrey (April 20).

ASSISTANT LECTURERS IN PHILOSOPHY, PHYSICS and GEOLOGY, and a LECTURER or ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, University College of North Staffordshire, Keele, Staffs (April 22).

CHAIR OF PHYSICS in the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

DIRECTOR—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (April 30).

INTERMEDIATE and JUNIOR FELLOWSHIPS IN CANCER RESEARCH—The Secretary-General, British Empire Cancer Campaign, 11 Grosvenor Crescent, London, S.W.1, endorsed 'Intermediate' or 'Junior' Fellowship (April 30).

JUNIOR PLANT PHYSIOLOGIST (with good honours degree in botany with special reference to plant physiology, and preferably with some postgraduate experience) under the Colonial Development and Welfare Cocoa Research Scheme—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (April 30).

LECTURER IN GEOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

LECTURER IN THEORETICAL PHYSICS—The Secretary of University Court, The University, Glasgow (April 30).

GRADUATE ELECTRONIC ENGINEER FOR WORK IN THE DEPARTMENT OF ANATOMY on the problem of counting and measuring microscopic particles, for research in television microscopy and its application to central nervous system—The Secretary, University College, Gower Street, London, W.C.1 (May 1).

I.C.I. RESEARCH FELLOWSHIPS IN PHYSICS, CHEMISTRY or related subjects—The Registrar, University Registry, Oxford (May 1).

LECTURER or ASSISTANT LECTURER IN CHEMISTRY at University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

RESEARCH SCHOLARSHIPS, GRADUATE SCHOLARSHIPS and STUDENT SCHOLARSHIPS—The Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2 (May 1 for Student Scholarships; June 1 for Graduate and Research Scholarships).

HUNTLEY AND PALMER'S AGRICULTURAL RESEARCH FELLOWSHIP—The Registrar, The University, Reading (May 2).

SENIOR LECTURER IN HYDRAULIC ENGINEERING at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 18).

BOOTS RESEARCH SCHOLARSHIP at the Long Ashton Agricultural and Horticultural Research Station—The Registrar, The University, Bristol (May 31).

JUNIOR LECTURER IN THE DEPARTMENT OF ENTOMOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (May 31).

LECTURER IN THE DEPARTMENT OF LAND SURVEYING, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

BURSARIES IN CONCRETE TECHNOLOGY tenable at the Imperial College of Science and Technology—The Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7 (June 1).

ENGLISH ELECTRIC COMPANY'S BURSARIES IN HYDRO-POWER ENGINEERING, tenable in the Civil Engineering Department of the Imperial College of Science and Technology—The Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7 (June 1).

NUFFIELD RESEARCH FELLOWSHIP for research on the scientific aspects of ageing—The Secretary, Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1 (June 1).

UNIVERSITY LECTURER IN ANTHROPOLOGY, and an ASSISTANT CURATOR IN THE MUSEUM OF ARCHÆOLOGY AND ETHNOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and Ethnology, Downing Street, Cambridge (June 1).

AGRICULTURAL ENGINEER, British Honduras, to organize and control two land clearing units for agricultural developments—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/31/01.

ENGINEER in the Ministry of Supply at Fort Halstead, to supervise design of test models and equipment, and operation and maintenance of large wind and water tunnels and other installations—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.139/53A.

MECHANICAL ENGINEER or PHYSICIST (with strong interest in technique of mechanical test creep of materials and instrumentation generally) FOR METALLURGY DEPARTMENT of the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.141/53A.

PRODUCTION CHEMISTS at Royal Ordnance Factories in S.W. Scotland, Lancs, Somerset and South Wales, to assist in technical control or administration for explosives and acids manufacture or ammunition filling, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.77/53A.

RESEARCH ASSISTANT (B.Sc. standard) IN THE CLINICAL RESEARCH LABORATORY, to work in the steroid field—The Secretary, Sheffield No. 1 Hospital Management Committee, Nether Edge Hospital, Sheffield 11.

SENIOR BIOCHEMIST (non-medical) IN THE AREA PATHOLOGICAL LABORATORY—The Secretary, Shotley Bridge General Hospital, Shotley Bridge, Consett, Co. Durham.

SENIOR EXECUTIVE ENGINEER, Public Works Department, Aden—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/2/01.

SENIOR LECTURER IN PHYSICS, and a LECTURER IN TECHNICAL CHEMISTRY—The Secretary, Royal Technical College, Glasgow, C.1.

STATISTICIAN to help in planning and carrying out technological investigations in mills—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

TOBACCO OFFICER, Department of Agriculture, Tanganyika, to take charge of the Tobacco Experiment Farm—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/8/02.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Studies in Conservation: the Journal of the International Institute for the Conservation of Museum Objects. (About 2 Nos. a year.) Vol. 1, No. 1, October 1952. Pp. iv+48. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1952.) 21*s.* net. [112

Sight Reduction Tables for Air Navigation. Vol. 1: Selected Stars, Epoch 1955·0. (A.P.3270.) (Published on behalf of the U.S. Navy Hydrographic Office.) Pp. xl+325. (London: H.M. Stationery Office, 1952.) 21*s.* net. [112

The Health of the School Child: Report of the Chief Medical Officer of the Ministry of Education for the Years 1950 and 1951. Pp. 144+7 plates. (London: H.M. Stationery Office, 1952.) 5*s.* net. [912

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences.) Vol. 63, Part 4, No. 28: A Molecular Sum Rule. By D. ter Haar. Pp. 381–384. 1*s.* Vol. 63, Part 4, No. 29: The First Chemical Society, the First Chemical Journal, and the Chemical Revolution (Part 2). By Dr. James Kendall. Pp. 385–400. 2*s.* 9*d.* (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) [912

The Registrar General's Statistical Review of England and Wales for the Year 1950. (New Annual Series, No. 30.) Tables, Part 1, Medical. Pp. x+461. (London: H.M. Stationery Office, 1952.) 12*s.* 6*d.* net. [1012

Other Countries

Institut Royal Météorologique de Belgique. Publications, Series B, No. 2: Le temps en Belgique pendant l'année 1951 et ses rapports avec la production agricole. Par A. Vandenplas. Pp. 68. Publications, Serie B, No. 4: Peut-on faire pleuvoir artificiellement? Par Dr. L. Dufour. Pp. 16. (Uccle-Bruxelles: Institut Royal Météorologique de Belgique, 1952.) [1112

New Zealand Forest Service. Annual Report of the Director of Forestry for the Year ended 31 March 1952. Pp. 76. (Wellington: Government Printer, 1952.) 1*s.* 6*d.* [1612

Bulletin of the Museum of Comparative Zoology, Vol. 107, No. 4: Revision of the Species currently referred to Alepocephalus, Hallaurioeps, Bathytroctes and Bajacalifornia, with Introduction of Two New Species. By A. E. Parr. Pp. 253–270. Vol. 107, No. 5: Geographic Variation in the Red-eyed Towhee of the Eastern United States. By J. C. Dickinson, Jr. Pp. 271–352. (Cambridge, Mass.: Harvard College, 1952.) [1612

University of South Carolina Publications. Series 3: Biology, Vol. 1, No. 1: Distribution and Bibliography of the Amphibians and Reptiles of South Carolina, by James T. Penney; Fishes of Richland County, South Carolina, by Harry W. Freeman. Pp. 41. (Columbia, S.C.: University of South Carolina, 1952.) 75 cents. [1612

Commonwealth Fund. Thirty-fourth Annual Report for the Year ending June 30, 1952. Pp. xiii+42. (New York: Commonwealth Fund, 1952.) [1612